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ORIGINAL ARTICLES.

I.—On the Permanence of Continents and Ocean-Basins, with Special Reference to the Formation and Development of the North American Continent.

By Prof. Joseph Le Conte.

UNDER the influence, perhaps, of the prevailing idea of evolution in all things, the conviction has been growing in the minds of geologists in recent times that the larger features of the earth's surface have grown from the earliest times, and therefore that the places of the continents and ocean-basins have been substantially permanent. Prof. Dana is largely the originator and expounder of this view, and he has applied it with great skill to the American continent. But while I believe the view is substantially true, I cannot but think that it may be, and has been, pushed too far. It is true indeed that the opponents of the view have attributed to its advocates a strictness in the use of the term 'permanent' which they have never urged. It is true that by permanence is meant only permanence of *place*, not of outline, and that substantial permanence is not inconsistent with very large changes by oscillation, especially at the end of the great Eras. But, making every allowance for such latitude of meaning, there has been, undoubtedly, some confusion of thought and looseness of statement on this subject. We give a few examples.

Prof. Dana in his admirable manual, p. 149, gives a figure (fig. 206), which he calls "Archæan map of N. America." This is really a map of *Areas of exposed Archæan rocks*, and for such it is doubtless intended. It cannot, of course, be a map of the land of *Archæan* times (since Archæan rocks were formed on sea-bottom), but is approximately a map of land of early *Silurian* times. But being called an Archæan map of the continent, and being found in the chapter on Archæan times, the inattentive reader is led to infer that it represents land of that time; more especially as the rest of the present continent is spoken of and represented as submerged, and therefore by implication this part as, then, land. And as Prof. Dana afterwards treats these areas as the nucleus from which the continent was developed, he seems to begin this development from the *land of Archæan times*. I am quite sure that many have been misled by this figure and the accompanying statements.

Again, Prof. Chamberlin in his excellent "Geology of Wisconsin," vol. i. p. 62, gives a map somewhat similar to Dana's, which he

calls a "Map of Laurentian land." It is, of course, again a map of Laurentian rocks, and therefore not of land of Laurentian times. But being evidently intended as a map of land of some time, and being given in the chapter on Pre-Laurentian history, the inference is unavoidable that it is intended to represent the land at the *beginning of the Laurentian* (Archæan) *time*. It is hardly necessary to say it is, again, approximately a map of earliest Palæozoic (Primordial) times. Thus it has come to pass that many, without reflection, have held that the development of the American continent may be traced from a nucleus existing in Archæan times. But of this there is in fact not the slightest evidence.

On the other hand, Prof. Hull has recently published a very interesting and suggestive paper "On the Geological Age of the North Atlantic Ocean," [1] in which he tries to show that the places of the present continents were not declared *until the Mesozoic*. If this be so, then indeed the doctrine of the permanence of continents must be given up entirely; for the Mesozoic and Cainozoic together form but a small part of the entire history of the earth.

I believe that the truth lies between these extreme views. I believe that the place of the American continent was established and its nucleus formed *at the beginning of the Primordial time*; and that thus, in regard to the development of earth features, no less than of earth faunas, the name Primordial is peculiarly appropriate. This, I think, is the real view of Dana. I wish now to give as clearly and as briefly as possible what seem to me the main steps in the history of the American continent from the earliest times.

1. Of all rocks the Archæan are by far the most widely diffused on the American continent, although of course largely covered by later deposits. Not only do they form the surface rocks over large areas, but they seem everywhere to underlie other rocks; for wherever these latter have been pierced by wells or cut through by cañons, we find the Archæan beneath. It is hardly too much to say that they form the foundation rocks of the whole continent. If so, then, of course, in *Archæan times the American Continent was all sea-bottom*. Where was the land at that time? We know not for certain; but the subsequent development of the continent southward and westward suggests that its place was to the north-eastward. This view is farther strengthened by the fact that the development of the European continent south-westward would point to the north-westward as the place of the earliest land. Prof. Hull therefore, with much show of reason, assigns the North Atlantic as the place of the Archæan continent. The land from which such enormous masses of sediments were derived must have been indeed of continental proportions, and must have existed during immense periods of time, perhaps equal to all subsequent times put together. Its débris carried into south-eastward and south-westward seas formed the Archæan rocks of Europe and America.

2. At the end of the Archæan, America (and probably Europe also) *became largely land*. This is a point of very great importance,

[1] Trans. Roy. Dub. Soc., 1885, vol. iii. p. 305.

but not generally recognized. The evidence of this fact is found in the eroded condition, universal so far as known, of the Archæan rocks underlying all other rocks, even the lowest primordial. No one has ever seen conformable relation between the Archæan and any other later rocks. Not only is this unconformity found all about the border of the Canadian Archæan area and the Appalachian area and about all the smaller areas in the most widely separated parts of the continent, but the grand Cañon of Colorado cuts through the whole stratified series and into the Archæan exposing the line of contact, and we find the same unconformity; the St. Louis Artesian pierces the whole Palæozoic, and again from the sudden change in the character and condition of the rocks from unmodified into metamorphic, we must conclude unconformity. But unconformity means *eroded land surface*. Therefore we must conclude that well-nigh the whole continent was land at the end of the Archæan. It is almost certain therefore that at the end of the Archæan, there was a veritable exchange of sea and land, and that the North Atlantic Archæan continent became sea at that time. If so, the strata which were then formed, and of which the eroded surface of Archæan rocks is the sign and measure, are now beneath the sea, and therefore irrecoverably lost. This period between the Archæan and the Primordial I have elsewhere[1] called the "Lost Interval," because we have no record of it in the stratified rocks.[2] Judging by the amount of erosion of Archæan rocks, and also by the prodigious advance in the progress of life when the record commences again in the Primordial, this lost interval must have been a period of immense duration. There are in the history of the earth many other intervals, partially or locally lost, represented by local unconformities, the most important of which occurred at the end of the Palæozoic; but none of these are to be compared with that which occurred at the end of the Archæan.

3. The Palæozoic commenced with another large crust-movement, but not a complete interchange of sea and land as before. The American continent was again largely, but not completely submerged. It went down until only the now-known Archæan areas, together with an eastern area of unknown size now covered by the sea, were left. The continent then consisted of a large V-shaped land-mass corresponding to the well-known Canadian Archæan area, a large eastern land-mass, including the Appalachian Archæan area, but extending eastward at least as far as the submerged continental border, and a large mass in the Rocky Mountains, and especially in the Basin region, while a great interior continental sea occupied the position of the drainage basin of the Mississippi river. The so-called map of Archæan land of Dana and Chamberlin would represent approximately the condition of things at this time, if the eastern border-land were extended as far as the submerged continental

[1] Am. Journ. Science, 1877, vol. xiv. p. 101. Le Conte's Elem. of Geol. p. 291.

[2] Some intermediate rocks have been found, *e.g.* the Kewenawan series, but the gap is still immense.

border.[1] *This*, the Primordial continent, *was the nucleus*, from which, by gradual growth, as so well shown by Dana, the American continent was formed. This growth was somewhat regular during the Palæozoic, but with another large oscillation at its end. The American continent existed, indeed, before, not however during the Archæan, as many seem to think, but during the "lost interval"; but it was almost destroyed at the beginning of the Palæozoic, to recommence its development with the nucleus already described. Thenceforward the plan thus outlined was apparently never lost.

4. During the Palæozoic the growth of the continent was comparatively regular, but at its end coincidently and correlatively with the formation of the Appalachian Range, the eastern land-mass was greatly diminished by submergence, and the eastern coast-line advanced westward far beyond its present position, especially in the southern part, probably as far as the well-known position of the Tertiary coast-line. After this oscillation, the development was again more regular, and in its broader outlines is well known. The great interior Palæozoic sea was diminished and became the interior Cretaceous sea, and this later retreated southward, to become finally the present Gulf of Mexico. There were probably many other times of lesser oscillation. The last of these was in later Tertiary and early Quaternary, during which the continent in its northern part again extended to the submerged continental border, with probable connection with Europe in the North Atlantic region.

Prof. Hull, in his paper already referred to, makes the changes in the latter part of the Palæozoic and at its end much greater than I have supposed, in fact equivalent to another almost complete exchange of sea and land. According to him (see his map, fig. 3), during the Carboniferous the whole of the North Atlantic and the northern parts of North America and of Europe formed together an enormous continental mass, the oceanic part of which was again submerged at the end of this period, to nearly the present limits of the two continents. It is not impossible nor even improbable that during the later Palæozoic the American continent may have grown on its eastern margin; or even that at some time during the long Palæozoic era there may have been a connection far to the north between the two continents; but of the complete abolition of the Atlantic Ocean, as shown on his map, I confess I see no sufficient evidence. The great thickness of the Carboniferous strata would, it is true, require a large land-mass to the east; but there is no reason why the eastern land-mass, which sufficed to contribute the 30,000 feet of Silurian and Devonian sediments, should not have been sufficient to contribute the much smaller amount of sediments of the Carboniferous period.

To re-capitulate briefly: 1. During the Archæan the American continent probably did not exist at all. 2. The first evidence we find

[1] The Silurian continent has been thus extended by Prof. Hull in his map, fig. 2; but why he has carried the northern part of the continental border westward so as to cut through Labrador, I cannot imagine. The whole of Labrador was surely land in Primordial times.

of its existence is during the "Lost Interval." It was then a large land-mass of unknown size and shape, but evidently of continental proportions. 3. At the beginning of the Palæozoic this continental mass was nearly lost by submergence; all that remained being the well-known Archæan areas, with a large extension on the eastern margin of the present continent. The masses formed the nucleus from which grew the present continent, with more regularity than before, but with some very large oscillations, the greatest of which was at the end of the Palæozoic, and the last of which was at the end of the Tertiary and beginning of the Quaternary.

Berkeley, California, *January 14th*, 1886.

II.—Note on the Geological Relations of Rocks from Assouan and its Neighbourhood.

By Sir J. William Dawson, C.M.G., LL.D., F.R.S.

DR. BONNEY having been so kind as to examine microscopically and describe a collection of crystalline rocks which I made in the vicinity of Assouan on the Nile, I have prepared the following notice of the geological conditions, to accompany his descriptions, referring, however, to the notes on the locality given in my paper in the Geological Magazine for Oct. 1884. Reference may also be made to the paper of Lieut. Newbold in the Journal of the Geological Society, vol. iv., and to that of Mr. Hawkshaw in the same journal, vol. xxiii. Lartet has given in his Geology of Palestine a summary of the observations of Russegger, Rivière and Figari Bey on the crystalline rocks of the Nile, and the allied rocks of the Sinaitic Peninsula have been described by him, by Bauerman[1] and by Holland,[2] and more recently by Hull.[3] All these authors have given, more or less distinctly, a series of gneisses and micaceous and hornblendic schists associated with intrusive granites and diorites as the oldest rocks of these districts, and succeeding these in geological age, certain slates and associated rocks, with porphyry and basanite in beds and veins.

The best section which I had an opportunity to examine of the older series was near the town of Assouan, in a railway cutting crossing the ridge between the river and the valley lying to the east of the town, and which exposed the beds in a perfectly fresh and unweathered state for about a quarter of a mile, beyond which they were more or less imperfectly seen for about 800 yards, until they were covered by the lower beds of the Nubian Sandstone unconformably superimposed on them.

I have given a section of the beds exposed in this cutting in the paper above cited. They are nearly vertical with a strike N. 10° E. As seen in the cutting, about four-fifths (Series *A* in Note) of the thickness exposed consisted of schists with black mica and black hornblende, the remainder being orthoclase gneiss regularly stratified and numerous dykes of reddish hornblendic granite (Series *B.* in Note). Further to the south the same rocks are seen to be

[1] Quart. Journ. Geol. Soc. vol. xxv. [2] Ord. Survey Sinai. [3] Mount Seir.

traversed by great dykes of diorite, and the mass or dyke of granite which has been the most extensively quarried is situated to the north along the course of the same ridge. Some of the crumbling schists seen in the valley behind the town may have been calcareous, and may be associated with limestone now concealed, but no limestone was observed, though the character of the beds in comparison with those I have elsewhere seen might lead to the expectation of its occurrence in the vicinity.

The Nubian sandstone, where it rests on these rocks, has, in its base, layers of conglomerate and of a calcareo-argillaceous indurated marl, but holds no fossils. It may be of Cretaceous age, but I should infer, from the character of the fossil wood (*Araucarioxylon Ægyptiacum*)[1] found in it elsewhere, and described by Schenk in Zittel's work on the Geology of the Nubian desert, that its lower beds at least may be Permian or Carboniferous.

The lithological aspect of the beds seen in the cutting at Assouan is that of the Middle or Grenville series of the Laurentian in Canada; indeed I find on comparison that the greater part of the rocks are not distinguishable in hand specimens from those occurring in this series on the Ottawa River.

In the Island of Biggeh, above the cataract, and on the higher parts of the mainland in its vicinity, there appears another formation (Series *C* in Note), very different in its mineral character, which, though older than the Nubian sandstone, I believe to rest unconformably on the older Assouan Series. In Biggeh the latter is seen in the lower part of the island in a vertical attitude and with strike N. 10° W. Strikes ranging from about N. 10° W. to N. 10° E. appear to prevail in this series, in the vicinity of the cataract, though in one place east of Assouan it was observed to be N. 70° E. Rising above the lower series, and apparently resting upon it unconformably, is a second series of beds nearly horizontal, and about 100 feet in thickness. They are composed as follows in ascending order:—

(1) Hard dark-coloured quartzose porphyry, with crystals of red orthoclase.

(2) Fine-grained granulite or granite, possibly a *remanie* rock.

(3) Black fine-grained laminated and in some places shaly rocks, referred by Professor Bonney to quartziferous kersantite.

(4) Granulite, like No. 2.

(5) Dark-coloured porphyry, with dark crystalline paste, and large crystals of opaque brick-red orthoclase.

The last is a very thick bed, and dividing along straight joints into huge cubical blocks, gives a castellated appearance to the hill and cliffs composed of this formation.

As seen from a distance, these rocks of the Second or Upper Assouan series appeared to be intrusive masses; but on nearer examination, they showed horizontal bedding, and at the base of the cliffs and in their ravines were seen to rest on the older series.

Assuming on the evidence of mineral character the Lower Assouan series to be Laurentian, and of Middle Laurentian age, the next

[1] See W. Carruthers in Geol. Mag. 1870, Vol. VII. p. 306, Pl. XIV.

rocks to be expected in ascending order would be the Upper Laurentian or Norian and the Huronian. To the former the second Biggeh series bears no resemblance, but there are known to be in the Arabian chain, and probably associated with the equivalents of the Assouan rocks, Norian rocks of the character of anorthosite gneiss, a rock which was used by the ancient Egyptians for statuary,[1] but is generally called diorite by antiquaries, though it differs very much from the true diorites of the country.

Dr. Schweinfurth has sent me from the districts of the Arabian chain north of Assouan, a rock similar to the more compact variety of the dark Biggeh rock, which he states forms ridges parallel to the main chain of crystalline rocks. Newbold refers to greenish and chocolate-coloured schists and quartzite, as bordering the older schists and granites, and Lartet notices talcose and chloritic slates with granulite in a similar relation, crowned by the celebrated green conglomerate and breccia of Kosseir and Gebel Doukhan. Further, Russegger connects the red porphyry and petrosilex porphyry with large felspar crystals of Gebel Doukhan with this second series, and Lartet has described the quartziferous porphyry of Mount Hor as lapping around the granite nucleus of that mountain.

It would thus appear that the old Laurentian gneisses and schists of Upper Egypt and its eastern mountain chain are succeeded by formations which may be held to represent the Norian and Huronian series at least, and I would regard the Biggeh formation or Second Assouan series as consisting mainly of bedded volcanic material representing some portion of the Huronian, a formation which would seem to have been more largely developed or to be better preserved in some parts of the Arabian chain to the north and east, where it is also overlain by slaty rocks, and by the green conglomerate which either constitute an Upper Huronian series, or may represent the Ammiké and Kewenian formations of America. There would seem in this district to be a great geological hiatus between these old rocks and the Nubian Sandstones.

III.—Note on the Microscopic Structure of some Rocks from the Neighbourhood of Assouan, collected by Sir J. W. Dawson.

By Prof. T. G. Bonney, D.Sc., LL.D., F.R.S.

I HAVE not deemed it necessary to examine microscopically the whole of the collection made by Sir J. W. Dawson, but have selected a series of fairly representative specimens, sufficient, I think, to give a general idea of the principal varieties. For purposes of identification I leave the reference numbers borne by the specimens, though their sequence is accidental.

(*A.*) Older Gneissic Series, Assouan.

(3.) A moderately fine-grained holocrystalline pink and white rock, speckled with black, of slightly gneissic aspect.

Microsc.—Quartz, felspar, orthoclase with some microcline and plagioclase, biotite, occasionally showing signs of alteration to the

[1] The fine statue of Kaphra or Cephren in the Boulak Museum is of this stone.

usual green mineral, a little apatite, and a small yellowish mineral probably sphene. The rather irregular outline of the felspars and the granular aggregation of the quartz resembles in some respects the structure of a gneiss rather than a granite, but it is very probable that this structure is the result of some pressure and crushing after the consolidation of the rock, of which the hand specimen gives indication: in all other respects one would not hesitate to call it a granite.

(4.) A rather fine-grained holocrystalline rock, speckled pinkish and dark coloured.

Microsc.—Quartz, felspar (orthoclase, microcline, and plagioclase), with a considerable amount of brown mica, a little apatite and epidote or sphene, with a very little iron peroxide. It is extremely difficult to say whether this be a gneiss or a granite crystallizing after the vein granite type (granulite of Fouqué and Lévy), modified slightly by subsequent pressure. After all, perhaps, some of the very coarse ancient gneisses may be only crushed and recemented granites.

(5.) A rather fine-grained holocrystalline rock, speckled pinkish and dull green; general tint inclining to dark.

Microsc.—The remarks on (4) will apply here, except that there is rather more biotite and apatite. The structure also is more gneissic, but it is very doubtful from indications given by the slide whether we can trust this, and whether the rock may not originally have been a granite.

(7.) A dark crystalline hornblendic rock, with a slightly fissile structure.

Microsc.—Holocrystalline; hornblende and felspar (chiefly plagioclase), a little epidote (probably) and magnetite, a flake or two of biotite, and a very little apatite. Very difficult to decide upon the origin of this rock. I incline to think it igneous, and a diorite.

(8.) A rather dark grey and pink, somewhat finely crystalline rock, with fairly distinct foliation.

Microsc.—Quartz, felspar,—orthoclase, a little microcline, plagioclase (? albite),—biotite, with a little iron peroxide, and a very little apatite. The structure much resembles that of one of the old Laurentian gneisses, which is also in accordance with the macroscopic aspect of the rock.

(11.) A gneiss distinctly streaked with pinkish felspathic and dark hornblendic or micaceous bands; the former, with occasional rounded felspars, have an aspect suggestive of much crushing. This appearance is fully confirmed by microscopic examination. The rock has evidently been once either a hornblendic granite or a granitoid gneiss, and its present structure is due to great crushing, so that in parts it is like an ordinary fragmental arkose. The dark mineral appears to be chiefly hornblende, though much biotite is also present; its crystalline grains are mostly small. Orthoclase, microcline and plagioclase were probably among the felspars of the original rock. There is some apatite, also sphene (?), ilmenite (?), and a crystal of a dark brown mineral unknown to me.

(12.) A very dark distinctly foliated schist, composed chiefly of

mica and a decomposed (?) felspathic mineral; some of the mica has a brassy lustre. The attempt to obtain a slice of this rock has been a failure, as it is so friable.

(13.) A hard quartzose schist, with not much mica, and little signs of foliation.

Microsc.—The principal constituents are quartz, felspars of more than one species, and brown mica. The rock appears to have been squeezed, but not crushed. It has the aspect of a true gneiss, one of the fine-grained kinds that rather resemble quartzites.

(14.) Rather like (12), but with a felspathic vein.

Microsc.—Dominant minerals, plagioclase, biotite, hornblende, some quartz, but variable in distribution. Parts of the slide might thus be called hornblendic gneiss, the rest rather hornblendic mica-schist. The rock certainly must now be called one of the above names, but there are peculiarities in its structure which prevent me from making any confident statement as to its origin.

(15.) A rather 'slaty' fine-grained gneiss, related to (13), but more fissile.

Microsc.—It has a general similarity to (13), but contains more mica. Also it has yielded more to pressure.

I may add that among the specimens from this series are several rather fine-grained dark mica-schists or very micaceous gneisses, varying between (12) and (15), which are so obviously representatives of the "metamorphic" group of rocks, that I have thought it needless to examine them under the microscope. They have a general resemblance to schists not unfrequent in the upper parts of the Hebridean series of Scotland, and may be compared with some of those which occur (for example) in the neighbourhood of Gairloch (Ross).

(*B.*) Rocks Intrusive (Dykes, etc.) in Series A.

(1.) A holocrystalline rock, mottled dark green (almost black) and light yellowish, with porphyritic felspar crystals of latter colour, sometimes about one inch long.

Microsc.—Consists of quartz, felspar—orthoclase, microcline, plagioclase (albite?)—hornblende, biotite; with a little magnetite, a good deal of apatite in well-defined hexagonal prisms, and a little of a granular yellowish mineral, probably sphene. Thus the rock is a hornblendic-granite; it is not very rich in quartz.

(2.) Coarsely crystalline rock, with large pinkish-red felspar crystals, quartz, some whitish felspar and black mica. One of the granites commonly used in Egyptian monuments, and, as is often the case with these, it has a gneissoid aspect.

Microsc.—Holocrystalline; quartz felspar, chiefly microcline, with some plagioclase, brown mica, with a little hornblende, a little magnetite, some apatite, and a yellowish mineral; sphene, or perhaps epidote. The irregular outline of the felspar and the aggregated granules of quartz resemble a gneiss, but this may be due to subsequent crushing.

(6.) A holocrystalline rock, moderately coarse, speckled with light greyish colour and black (mica).

Microsc.—Quartz, felspar (orthoclase, microcline, and plagioclase), a good deal of biotite and hornblende, rather rich in apatite, some magnetite, some sphene (one crystal rather large), also several long colourless needles, ? sillimanite; a hornblendic granite, rather poor in quartz.

(*C.*) Upper Series at Biggeh (Assouan).

(9.) A dark rather compact rock, with but slight indication of a schistose structure.

Microsc.—Holocrystalline; quartz, felspar (apparently both orthoclase and plagioclase, but not very well characterized), biotite and hornblende, with a little magnetite, apatite, and sphene. It resembles a hornblende schist, but slightly foliated, rather than an igneous rock.

(10.) A dark rather compact massive rock with rectangular jointing.

Microsc.—Holocrystalline, but not coarse, composed of biotite, rather dark-coloured, but partly altered into a greenish mineral, and hornblende with some quartz, and a fair amount of felspar, which seems commonly to be plagioclase; a little apatite, magnetite or hematite, and sphene. The mica (with perhaps the hornblende) appears to have been the first mineral to crystallize. The rock appears to me to belong to the mica-trap group, and to be a quartziferous kersantite.

(16.) A dark rather fissile rock, looking more like a bad slate than a true schist.

Microsc.—At first glance it seems very fragmental, but on careful examination I feel convinced that we are dealing with a crushed crystalline rock, which has consisted chiefly of felspar and hornblende. There is a fair amount of apatite, and some of the hexagonal crystals appear to have escaped the crushing, or have been subsequently formed. I notice a few flakes of brown mica and there are indications of iron oxides. Thus it is now a schistose rock, not of a highly metamorphic aspect, but has been made out of a diorite or a hornblende schist.

The "coarse dark-coloured porphyritic rock" from this series (No. 1 of Sir J. W. Dawson's series at page 440 of the volume of this Magazine for 1884), if I have rightly identified the specimen, is holocrystalline and it appears to me to be a true granite. I may add in regard to this "upper series" that, if I am right in my interpretation of (16), the specimens do not suggest to me the necessary existence of a wide gap between them and those of the lower series; that some appear to me igneous rocks, and that the others, if not igneous, belong to a highly crystalline group of rocks.

Remarks.

I have had to speak with some hesitation as to the nature of certain of the above described rocks. This is always needful in dealing with any series of very old rocks, especially when one has not had the opportunity of examining them in the field, because we are not yet sure of the significance of certain structures and their relation to

the origin of the rock. But while I cannot positively assert that some of the rocks included in series *A* (Older Gneissic Group) may not be rocks of igneous origin, to which a schistose structure has been imparted by subsequent pressure, I think it highly probable that they assumed their present character at a very remote period in the world's history, and may remark that this difficulty is one which frequently confronts us in examining the older Archæan series. But, while admitting this uncertainty, I observe in some of the specimens the structures which I have been accustomed to note as characteristic of the older gneisses, and was independently struck with the resemblance which some of them presented to specimens collected by myself in Canada and in N.W. Scotland, especially in the case of (13), which is very like to a "quartzose gneiss," high in the Grenville series, shown to me by Sir W. Dawson in 1884, near Papineauville Station on the Ottawa river. Thus the series as a whole may safely be regarded as petrologically "homotaxial" with the middle part of the Canadian Laurentians.

IV.—On the Occurrence of Two Species of Madreporaria in the Upper Lias of Gloucestershire.

By Robert F. Tomes, F.G.S.

THE few recorded Madreporaria of the Upper Lias possess considerable interest on account of the great generic as well as specific differences which exist between them and those from the Middle and Lower Lias, though it might seem probable that the discovery of a greater number of species would diminish that discrepancy. Such a conclusion has not, however, by any means been substantiated by further acquaintance with those from the Upper Lias of the district of which I am about to speak.

The late Mr. Charles Moore in his exhaustive paper, "On the Middle and Upper Lias of the South-West of England,"[1] gives sections of the Upper Lias exposed in quarries on the hills at Stanley and Dumbleton. Both these places are in the eastern part of Gloucestershire, and a reference to the paper above quoted will show that the sections there very closely resemble each other. The quarry on Stanley hill is now closed, but a waste heap yet remains, on the upper surface of which are numerous little hillocks of weathered clay and shale. They represent the barrow loads of clay from near the bottom of the quarry, which have been wheeled out by quarrymen preparatory to lifting the Middle Lias Marlstone below. The influence of weather having first reduced these hillocks to a light blue or grey mud, and afterwards dried them into the consistency of ashes, a considerable number of small lenticular corals were found on their surface, and many were collected during the summer of 1885 by my friend Mr. T. J. Slatter, and myself. Belemnites occurred in great abundance, as well as small Ammonites (probably *Ammonites Hollandrei*), but although in near association with the corals, they were not found mixed together. In much nearer approximation were

[1] Proceed. Somerset Arch. and Nat. Hist. Soc. vol. xiii.

numerous small glittering crystals of pyrites, small Gasteropoda, fragments of Pentacrinites, and Acrosalenias.

With a view to determine, if possible, the precise stratigraphical position of the corals, I visited the Dumbleton hill quarry, only three miles distant, still in work, and satisfactorily determined their horizon.

The following is an accurately measured section, showing the beds at present exposed:—

	ft.	in.
1. Surface soil	4	0
2. Fish bed, fine grained and laminated stone, with Saurian remains, *Lepidolepis concentricus*, and insects	1	0
3. Laminated blue shales	14	0
4. Layer of intermittent nodules of hard stone containing fucoids	0	3
5. Laminated blue shale, like No. 3	3	0
6. Whitish grey clay, hard and breaking up into angular lumps, and weathering into a soft light-coloured clay	0	9
7. Hard light blue shale, in the lower part of which are many Belemnites, and in the upper part numerous small cubes of pyrites, small Ammonites (*A. Hollandrei*) and Gasteropods	1	3
8. Friable shale, having the appearance of soft marlstone, brown or ferruginous in colour, and sometimes micaceous	1	0
9. Middle Lias Marlstone, very fossiliferous	3	0
	28	3

All the beds downwards, until we arrive at No. 6, are finely laminated, and it would be time wasted to seek for corals in them. However beds 6 and 7 are wholly different. The first of these, No. 6, is light-coloured and hard, breaking up with the hammer into more or less square or angular lumps. It appears to contain very few fossils. No. 7, like the one above it, is not laminated, but is bluer, softer, and much more fossiliferous. Near to the bottom of it are Belemnites in abundance, and it also contains a great many small specimens of *Ammonites Hollandrei*. Very near to, or at the top, are a great number of crystals of pyrites, similar to those at the Stanley hill quarry. These two beds weather down into a soapy and disagreeable mud, and this perhaps accounts for their having been wheeled well back on to the top of the waste heap out of the way, both at Stanley and Dumbleton. The corals are much less common at the latter than at the former place, only two specimens having been met with. Both were in close proximity to the layer of pyrites, and in the top part of bed No. 7, or in the division between that bed and No. 6. At Stanley hill, where the corals are plentiful, they were found either in association with the pyritic crystals, or in a lighter coloured mottled clay, such as would be caused by the weathering down and mixture of beds Nos. 6 and 7. The conclusion at which I arrived, after making examination, was, that they lie chiefly between the two above-mentioned beds, and that they denote a quiet period during the deposition of the transition beds from the Middle to the Upper Lias. This is also the position of the peculiar so-called *Montlivaltia* which occurs in the transition beds from the Middle to the Upper Lias at Adderbury and Chipping Warden, Oxfordshire, to which I gave the name of *Montlivaltia tuberculata*.

Bed No. 8 is, without doubt, the top of the Middle Lias, dif-

fering only from the Marlstone beneath in being less compact. As I have already stated, the late Mr. Moore gave sections of the Upper Lias exposed in the quarries on the hills at Stanley and Dumbleton, a reference to which will show that the two sections very closely resemble each other.

In the paper alluded to is also a detailed section of the Upper Lias at Ilminster, from which Mr. Moore obtained the corals figured by MM. Milne Edwards and Haime, under the names of *Thecocyathus Moorei*, and *Trochocyathus primus*. A comparison of the Ilminster section with the one here given of the Upper Lias at Dumbleton hill will show that the corals from the latter place and from Stanley hill occupy a very different place in the section to the species just mentioned; but they, as already observed, correspond stratigraphically with those from Adderbury and Chipping Warden, and one of the species, as I shall show, is the same.

Two species, representing two genera, were collected at Stanley hill, namely *Thecocyathus* and *Trochocyathus*.

THECOCYATHUS TUBERCULATUS, Tomes.

Montlivaltia? tuberculata, Tomes, Quart. Journ. Geol. Soc., vol. xxxiv. p. 192, 1878 (read 1877).

The greater number of the specimens collected at Stanley hill are referable to the species which I have erroneously, but with an expression of doubt, described as a *Montlivaltia*, under the name of *Montlivaltia? tuberculata*. Their state of preservation being very superior to that of the Oxfordshire specimens, from which I took my description, I am now enabled to amend it very considerably, and to place the species in another genus.

All the Stanley hill specimens are rather smaller than the ones from Adderbury or Chipping Warden. The general form of the corallum is similar in the specimens from all these localities, and the calice of those most satisfactorily preserved is superficial, and varies from a slight convexity to a slight concavity. There are three complete cycles of septa and a rudimentary fourth. Those of the first pass quite into the columella, and those of the second approach it very nearly. The septa of the third cycle are two-thirds the length of those of the second. Those of the first and second cycles have their outer half crenulated rather than tuberculated, while their inner half has strongly marked paliform tubercles, which are four in number on the primary septa, and three on the secondary ones. Sometimes there is a single paliform tubercle on the septa of the third cycle, but this does not seem to be a constant character, and its appearance is perhaps regulated by the age of the individual. In some specimens these tubercles are much more prominent than in others, but all in the same calice have an equal prominence and are equal in size. The columella has very little prominence; it is small, porous, and irregular, and the tubercles on its upper surface correspond with those on the septa from which, in the unworn calice, they are undistinguishable. The appearance presented by the most perfect examples is that of a central area filled with equal, round, and equally prominent tubercles; but when

the calice is rubbed or worn down, these all disappear, and the simple septa are seen to pass quite up to the columella. The sides of all the septa have rather distant but well defined and prominent tubercles.

Compared with *Thecocyathus mactra*, the present species differs in its smaller size, its much more rugose epitheca, and in its pali, the margins of which are much more tubercular. The tubercles are undistinguishable from those of the columella, with which they appear to blend.

I may take this opportunity of observing that with access to a considerable collection of specimens of *Thecocyathus mactra*, and *Thecocyathus tintinnabulum*, as well as to a number of species of *Thecocyathus Moorei* from the Upper Lias of Ilminster, I am not only satisfied of the distinctness of the species from the Upper Lias of Gloucestershire and Oxfordshire from the others, but am fully prepared to follow M. de Fromentel in putting together as one species *Thecocyathus mactra* and *Thecocyathus tintinnabulum*.

I also avail myself of the present occasion to make a few remarks on the genus *Thecocyathus*. Amongst the most ancient of the *Turbinolidæ*, this genus might not unnaturally be expected to possess characters approximating it in a greater or less degree to the Lower Mesozoic *Astræidæ*, with which in time it is so nearly associated. None of the *Turbinolidæ* have to my knowlege been met with in the Lower or Middle Lias, but I may observe that although the *Montlivaltia radiata*, of Duncan, which occurs in the bottom of the Middle Lias, or perhaps at the junction of the Middle with the Lower Lias, has an abnormal and primitive number of primary septa, it nevertheless has a very thin epitheca scarcely obscuring the costæ, which is quite unlike that of any genus or species of older date.

Again, the sides of the septa of *Montlivaltia mucronata*, which is found associated with the last species, are ornamented with thickly crowded flattened tubercles, instead of the vertical ridges which characterize nearly all the Jurassic *Montlivaltiæ*. These peculiarities seem to indicate some affinity in both these species with more recent forms.

In *Thecocyathus tuberculatus* we have a very modified development of the inner ends of the principal septa, which is no doubt equivalent to the growth of pali, and the same sort of development takes place to a considerable though more limited extent in *Thecocyathus Moorei*, for I observe that when the calice is ground or worn down, the pali are with difficulty traceable. Some of the much worn specimens are undistinguishable from *Montlivaltiæ*, having columellæ formed by the fusion of the septa in the centre of the visceral cavity. The genus *Thecocyathus* must therefore, I think, be regarded as very sub-typical of the *Turbinolidæ*—the precursor, in fact, of the more typical genera.

Nearly allied to *Thecocyathus* is *Trochocyathus*, but unlike the former, which continued into the period of the Lower Oolite and no longer,[1] the latter lived on through the Secondary and into

[1] I limit my remarks to such species of *Thecocyathus* as have been met with in this country, one of which has been obtained from the Inferior Oolite of Dorsetshire. M. de Fromentel describes four as occurring in the French Oolites.

Tertiary times. *Trochocyathus primus*, which has been found associated with *Thecocyathus Moorei* high up in the Upper Lias of Somerset, is a very doubtful form, and the same may be said of the still earlier species spoken of in the present paper. But in *Trochocyathus magnevillianus* we have proof of the occurrence of an unquestionable and more typical Turbinolian in the Inferior Oolite. Of its precise position there I am unable to speak, but have great reason for supposing that it is only a little removed from the Cephalopod bed of the Upper Lias.

TROCHOCYATHUS.

With the preceding species occurs another coral which I refer to the genus *Trochocyathus*. All the specimens, which, however are few in number, are small in size and broadly attached, and in this respect are more like examples of the genus *Paracyathus* than *Trochocyathus*. They are wholly destitute of epitheca, and their mural costæ are well defined and have transverse crenulations. The calice is ovoid, convex, and consists in all the specimens I have examined of a confused mass of tubercles, which are more distinct towards the centre than outwardly. Neither the cycles of the septa, nor the pali can be satisfactorily traced.

Height of the corallum, 1 line. Greatest diameter of the calice, $1\frac{1}{2}$ line.

V.—On a Recent Legal Decision, of Importance in Connection with Water Supply from Wells.[1]

By W. Whitaker, B.A., F.G.S., Assoc. Inst. C.E.

ABOUT, or nearly, forty years ago, two deep wells (with borings) were made at Brentford, which, passing through Gravel, London Clay, and the Lower London Tertiaries, reached the Chalk at a depth of about 315 feet, and were carried some way into the last.

One of these wells is at the Brewery on the southern side of the High Street, now known as the Royal Brewery, and it continued in use till its water became unfit for brewing-purposes, from the cause noted below. The other is 99 yards off, north-eastward, at some printing-works at the back of the houses on the other side of the street. This one was made for a Distillery which has long ceased to exist: the well too having been abandoned, at least for its original purpose of water-supply.

Unfortunately, however, some years ago (from 1874 to 1882) the Distillery well, as we may call it, was turned to a baser use, being made into a cess-pit, by turning into it the drainage of the privy belonging to the printing-works. This misuse has ceased for some three years; but not before a considerable deposit had been formed in the well.

The water of the Brewery well, once of good quality, having been found to have become gradually contaminated, the owner, Mr. M. Ballard, sought to discover the cause, and, the misuse of the

[1] Read before the Congress of the Sanitary Institute of Great Britain, at Leicester, Sept. 25, 1885. Extracted from vol. vii. of the Transactions of that Institute.

Distillery well having come to his ears, he was led to attribute to that the falling off in quality of his own well-water, the use of which was at once discontinued.

This led to his bringing an action against the owner of the Distillery well, Mr. Tomlinson, for heavy damages, and, although the misuse of that well was then stopped, of course its effects on the water of the Brewery well did not cease, and were not likely to for some time. Having, in the course of the proceedings, been consulted on the Plaintiff's behalf, I may be allowed to call public attention to the importance of the question at issue.

That the two wells get their water from one common source, the Chalk (and perhaps, to some extent, from the overlying sands), is incontestable. When no pumping goes on at either, the water-level is the same at both, about 27 ft. down in the Brewery well, and 37 ft. in the other, the site of which is some 10 ft. higher.

Practical evidence, however, of the communication between the two was given by the Brewery well being pumped for 48 consecutive hours, whereby its water-level was lowered 78 ft. 9 in., and that of the Distillery well 14 ft. In order, moreover, to make assurance doubly sure, the lithium-test was applied at the suggestion of Dr. Frankland, and some of the lithium-chloride put into the Distillery Well was found to have been drawn to the Brewery well 48 hours afterwards.

The question, therefore, of communication between the two wells could not be disputed; it was clearly a fact, and the Defendant's case was based on purely legal points, which amounted practically to the statement that any man could do as he liked with his own well, a contention which was successful at the trial before Mr. Justice Pearson, in February, 1884.

The judge ruled that, as it had been decided in the well-known case of Chasemore *v.* Richards, no one had a right to underground water so far as *quantity* is concerned, or in other words that neither Plaintiff nor Defendant could be restrained from pumping each other's wells dry, or from carrying out works that might take away each other's supply, so also there was no right in *quality;* but that the Plaintiff, whilst having a perfect right to pump as much water as he liked, so as to draw away water from the Defendant's well, must take that water subject to everything that has occurred to it. If he did not pump up the water from his own well, he would not get the bad water from the neighbourhood of the Defendant's well. I must own that to my unlegal mind the idea of having a well without pumping water from it was somewhat amusing, and I was inclined to infer that if it had been a case of an overflowing well, from which the water was delivered by the natural force of gravity, instead of by the artificial force of a pump, the decision might have been different, though why I do not see.

In his decision the judge seems to have been somewhat influenced by the possibility that, if the law were otherwise, actions might ensue for like pollutions at great distances, instead of the trifle of 100 yards as in this case, and, in his judgment, he imagines a series of

litigants spreading the grounds for such an action over a distance of 60 miles. Though to a lawyer this may seem an inconvenient prospect, I think that sanitarians may be inclined to look on it with no disfavour.

The result of such a judgment amounts of course to saying that no underground water-supply is safe from contamination, even if wilfully brought about. Should your neighbour have a well with a good supply, and you wish to spite him, or to spoil his business, all that is needful would be to put down a bore to the source of supply, and to pour some poison down it! This matter, I believe, was noticed by one of the Plaintiff's counsel. Perhaps, however, in in such a case, or in one where sewage containing typhoid, or choleraic, evacuations was knowingly poured into a well, so as to foul a neighbouring one, the offender might be convicted of manslaughter, in a criminal case, though (under Mr. Justice Pearson's judgment) he would get the best of a merely civil action! This would certainly be a somewhat anomalous state of things, even as regards English law!

So many towns, institutions, and manufactories now get their water-supply by wells in the Chalk, and in other great water-bearing beds, that the result of such a judgment passing unchallenged would have been most serious. It would possibly indeed have been a great check to enterprise in that direction, as water thus got, perhaps at great expense, might at any time be made worse than that got from streams which are more or less contaminated.

The Plaintiff, however, was advised to take the case to the Court of Appeal, and all folk interested in the getting of pure water should thank the Master of the Rolls, and the Lords Justices Cotton and Lindley, for unanimously over-ruling the judgment of the Court below, as they did in February, 1885.

The Master of the Rolls holds that "although nobody has any property in the common reservoir or source [of underground water], yet everybody has a right to appropriate it in its natural state, and no one of those who have a right to appropriate it has a right to contaminate that natural source so as to prevent his neighbour from having the full value of his right of appropriation;" and he goes on to say, in answer to an objection that the water is got by artificial means (pumping), that "however he [the Plaintiff] may appropriate the water from the common source, he has a right to have that common source uncontaminated by any act of any other person." With regard too, to the question of distance, his judgment is equally satisfactory; for he says that "the question does not depend upon the parties being what is called contiguous neighbours. If it can be shown in fact that the Defendant has . . . . fouled . . . the common source, it signifies not how far the Plaintiff is from him."

Lord Justice Cotton draws attention to the fact that the Defendant was not using the water from his well, but only putting filth down the well, which does not amount to using a natural right, and by so doing, he "interferes with the exercise by the Plaintiff of a natural right incident to the ownership of his own land."

Lord Justice Lindley remarks that the case "really involves the question whether a person who has a well on his own land is at liberty to poison the water which supplies that well and a large district round about it. The defendant says he has such a right. It is a startling proposition to say the least of it." He adds that "the right to foul water is not the same as the right to get it. . . . . *Prima facie* no man has a right to use his own land in such a way as to be a nuisance to his neighbour. . . . . If a man chooses to poison his own well, he must take care not to poison waters which other persons have a right to use as much as himself. . . . . The right of a man to get water from his well is to get the water as nature supplies it."

As a geologist, much interested in the question of water-supply from underground sources, it was with a feeling of great relief that I heard of the view of this case taken by the Court of Appeal, and I read the full report of the judgments (from which the above quotations have been made) with much pleasure. I am inclined to think, indeed, that Mr. Justice Pearson, albeit he seems to hold strongly to the opinion that this is a free country, may feel relieved rather than grieved at the reversal of his decision. Had it been upheld, there would clearly have been great need of a little law-making.

Although all sanitarians must be glad of the final decision in this case,—for it will not be carried to the House of Lords,—yet it seems unfortunate that the privilege of bringing up so important a matter for settlement should have fallen to individuals instead of to corporations or to companies, on whom the expense would have more fairly fallen. It may be but a poor consolation to both Plaintiff and Defendant, that their names will become famous, like those of Chasemore and Richards, from the case of Ballard *v.* Tomlinson being one that is likely to be quoted for many years, as giving a most important decision in the law of water-supply from wells.

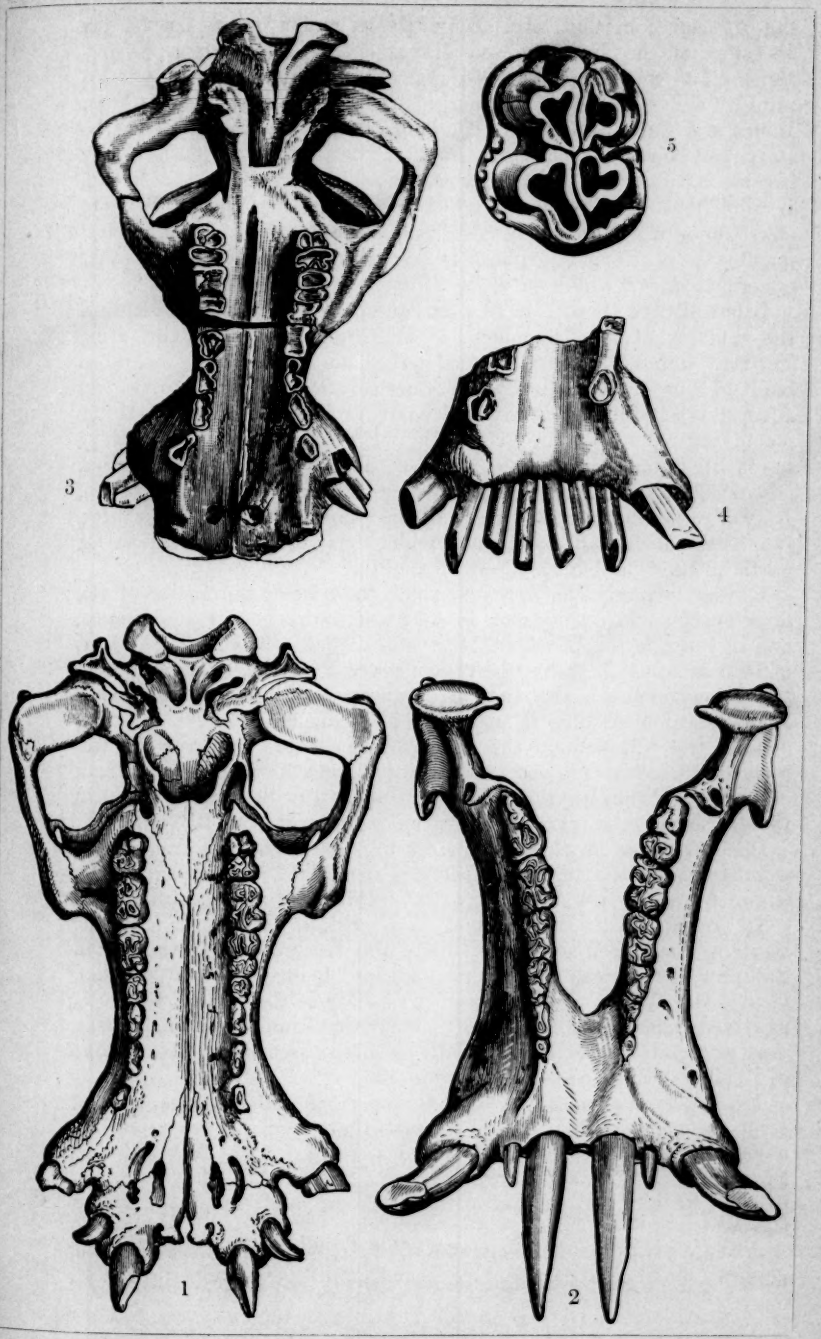
Whilst it was decided, in the earlier case, that every owner has the right to draw underground water to an unlimited extent, the decision now noticed is to the effect that no owner has the right to pollute a source of water-supply common to his own and other wells. Whatever may be the fate of the former decision, it is to be hoped that the latter one will never be altered.

VI.—Recent and Fossil Hippopotami.

By Henry Woodward, LL.D., F.R.S., F.G.S., etc.

(PLATE III.)

IN September last, I drew the attention of the readers of the Geological Magazine (Decade III. Vol. II. pp. 412–425) to a singular group of vegetable-feeding aquatic animals, the Sirenia, represented at the present day by two genera, *Manatus* and *Halicore*, and by at most six species, three or four of which are probably only varieties. A peculiarity of this group of animals is that whereas the two living genera are distributed in the subtropical regions East and West of



FIGS. 1, 2. *Hippopotamus amphibius*, Linn. (recent).
,, 3—5. ,, *sivalensis*, Falc. & Caut. (fossil).

the African continent, and to its rivers and opposite coasts, the ancestors of the Halicore and Manatee (the *Halitherium*, *Felsinotherium*, and some ten other fossil genera of Sirenians) probably intermingled and extended 30° further north than at present from the West Indies and Carolina through England, Belgium, France, Germany, Italy, and North Africa, whilst *Rhytina*, the largest of them all, only became extinct 100 years ago on the shores of Behring's Island, Kamtchatka. The evidence which the fossil remains of SIRENIA afford of a more northerly geographical extension of subtropical mammalia in Tertiary times, is abundantly confirmed by other genera, to one of which only, the *Hippopotamus*, I will here refer.

It has always seemed at first an anomalous circumstance to find the remains of the *Hippopotamus* and the Reindeer in the same Tertiary deposits, the latter belonging to the extreme northern lands of Europe, Asia, and North America, and the former to Central Africa; but in late Tertiary and early Prehistoric times, when our island formed a part of the mainland of Europe, the migratory herds of Reindeer not only reached this country in winter, but advanced as far south as into France and Spain; whilst the rivers of Italy, France and England were all the summer, if not the winter, the resort of the *Hippopotamus*, which has left its remains as far north as Leeds and Kirkdale in Yorkshire.

It was formerly customary to refer the numerous remains of the large species of *Hippopotamus* found fossil in this country, in France, and in Italy, to the *H. major*, of Owen (1843), or to the *H. antiquus*, of Desmarest (1822); but the researches of Prof. Boyd Dawkins have led to the conclusion that they all undoubtedly belong to the living African Hippopotamus, *H. amphibius* of Linnæus (1766).

Like the "Manatee," the *Hippopotami*, where undisturbed, frequent with equal pleasure the coast, as they do the rivers. North of Port Natal they are said not only to abound in the rivers, but upon the sea-shore, retreating to the sea when disturbed or attacked.

Such evidence as this enables us to understand the presence, in prehistoric times, of the *Hippopotamus* in Britain, at least during the summer season, even after its partial isolation from the continent.

Its remains have been found at Kirkstall, near Leeds; in the Norfolk Forest-Bed-series at Bacton, and Hasbro'; at Lavenham in Suffolk; at Barnwell, near Cambridge; at Chelmsford, Cold Higham, Grays, and Walton, in Essex; in the Valley of the Ouse at Bedford; at Greenwich, Kent; Peckham, Surrey; in Camden Town, in fact, very generally in the Thames Valley; often associated with remains of Reindeer, Rhinoceros, and Mammoth.

Hippopotamus-bones are less frequently found in caves, than in river-valley deposits; but in several their remains are recorded, associated with those of the Reindeer, namely:—Pont Newydd near St. Asaph, N. Wales; Kirkdale Cave, Yorkshire; Gower Caves, Glamorganshire; Cefn Cave; Settle Cave; and Durdham Down Caves.

An interesting and abundant find of Hippopotamus-remains was recently obtained at Barrington, near Cambridge (noticed by Mr. P.

Lake, Geol. Mag. 1885, pp. 318–320. The geology of the locality and its superficial deposits have been very accurately described by the Rev. O. Fisher, M.A., F.G.S., see Quart Journ. Geol. Soc., 1879, vol. xxxv. pp. 670—677.)

Of the European localities three may be specially noticed as yielding remains of *Hippopotamus amphibius* in considerable numbers, namely, at Perrier and Puy de Dome in France, and in the Val d'Arno in Tuscany.

I have argued from the presence of remains of Sirenia so widely distributed in the European Tertiaries a generally warmer climate, and I am glad to find that the late Dr. Falconer adopted the same view from the fact of the presence of remains of Hippopotami in so many English localities. This accomplished naturalist thus sums up his views:—"In speculating about the probable climatal conditions on the land in Europe during the Pliocene period, one of the fossil pachyderms has appeared to me capable of throwing more light than all the others, namely, *Hippopotamus major*. Two living species of this genus are known, the one *Hippopotamus amphibius*, and the other the small *Hippopotamus Liberiensis*. They are both found in the tropical or warmer parts of Africa. In their habits they are strictly aquatic, plunging into rivers during the day, and emerging at night to pasture along the river banks. They always hug the margins of the rivers or lakes, and are not known to make inland journeys away from them. When they migrate, they either float with the stream, or, if moving against it, they walk along the bed of the river, only leaving it for a short distance, when their course is interrupted by rapids, and replunging into the stream when the obstacles cease. Wherever they are found, they enjoy open water all the year round. Their unwieldy heavy form and short limbs are admirably adapted for their aquatic habits, but unfit them for journeying by land.

"There is no reason to believe that the huge European fossil species was in any respect less aquatic in its habits than its living congeners. Wherever its remains have been discovered in the greatest abundance and perfection, it has invariably been along the margins of rivers or great lakes, such as the Val d'Arno, where the bones of hundreds of individuals have been observed. It appears to have been spread over nearly the whole of the Pliocene area of England, since bones and teeth have been described from the valleys of the Severn, the Avon, and the Thames, Kirkdale Cave, Kent's Hole, and Durdham Down. The general argument, so ably discussed by Dr. Fleming, that we cannot predicate, in many cases, what the food and habits of extinct species of the same genus may have been, will not apply to the fossil *Hippopotamus major*, which must have lived in open water free from ice, if it lived the whole year round in England. That it was capable of migration by land more than the existing species we have no grounds for believing; and if it is argued that there may have been large rivers flowing from the south during the Pliocene period, along the course of which the Hippopotami could have migrated during winter, the argument might apply to the population

of one or two river-valleys, but it would hardly extend to the Hippopotami spread over the broad area of England. In balancing these various considerations, it seems to me most probable that the *Hippopotamus major* was a permanent resident in the country during the Pliocene period. This would involve a comparatively warm temperature throughout the year as late as the deposition of the 'Grays Thurrock' beds, and the same would seem to be indicated by the presence of some southern freshwater shells,[1] which are now extinct in England."[2]

The living *Hippopotamus amphibius* appears to be met with on all the tributaries of the Nile, and was in earlier times abundant in Egypt also. It is still found on the Senegal and the Zambesi, and along the course of most of the rivers of the eastern coast, and along the coast itself, at many spots south of the equator to near Natal.

There is a second living species of Hippopotamus (*H. Liberiensis*), which is a much smaller animal than the common *Hippopotamus*. It rarely attains a weight exceeding four hundred pounds, or a quarter of a ton, as distinguished from the four tons weight attained by the male (Obaysch) which died at the Zoological Gardens in 1878, then twenty-nine years of age. One of the most important differences between the two consists in the fact that the Liberian Hippopotamus possesses only two incisors in the lower jaw.

The Siwalik Hills of India, whose older Pliocene deposits are so rich in the remains of Proboscidea and other Ungulata, have also yielded three species of *Hippopotami*, namely, *H. sivalensis*, F. and C.; *H. Iravaticus*, F. and C.; *H. namadicus*, F. and C., and one from the Narbadas, *H. palæindicus*, F. and C.

The first of these, *H. sivalensis*, is figured in our Plate (Plate III. Fig. 3–5); it is somewhat smaller than the existing species, *H. amphibius*, and has six incisor teeth in each jaw. This led Falconer to propose for those Indian forms with six incisors a new generic division, *Hexaprotodon*, the others being Tetraprotodont. *H. palæindicus* and *H. namadicus* evidently offer in the gradual diminution and squeezing out of one pair of their incisors, a distinct passage from the hexaprotodont to the tetraprodont type of the modern *H. amphibius*.

Prof. A. Gaudry has described a Pleistocene (?) species, *H. Hipponensis*, from Algeria. A small species of *Hippopotamus* has also been found fossil in Madagascar (Dawkins).

But perhaps the most interesting species met with in a fossil state are the *Hippopotamus Pentlandi*, H. von Meyer, and the *H. minutus* of de Blainville. The latter is from the Pleistocene Caves and fissures of the Island of Malta, where it has been found associated with the remains of the pigmy Elephant; the former was obtained from the Grotta di Maccagnone, near

[1] *Cyrena fluminalis* is common in the Brickearths of the Thames Valley in association with *Rhinoceros Elephas* and *Hippopotamus*. Now it is found living in the Nile, and in India and China.

[2] "Falconer's Palæontological Memoirs," vol. ii. pp. 207–208.

Palermo, Sicily. So abundant were the remains of this species (*H. Pentlandi*) in the various caverns near Palermo, that, for many years, the bones were exported by shiploads to England and Marseilles, for the manufacture of lamp-black for sugar-refining. Two hundred tons were removed from one cave (San Ciro) in six months. Dr. Falconer writes that literally tens of thousands of two species of *Hippopotami* have been found fossil in Sicily alone. Mr. Lydekker considers there is a complete gradation in size from the largest fossil individuals of *H. amphibius* through *H. Pentlandi* to the smallest specimens of *H. minutus*. Prof. Boyd Dawkins evidently considers that *H. minutus* and *H. Pentlandi* are varieties of the same, and that they extend from Malta to Sicily, and thence to Crete and the Morea. He adds, "It is closely allied to the Liberian species, although it is pretty certain that it differed from it in the form of its molar teeth." The Hippopotamus possessed the following series of teeth, viz.:—

$$\text{incisors } \frac{2}{2}\ \frac{2^{*}}{2} \quad \text{canines } \frac{1}{1}\ \frac{1}{1} \quad \text{molars } \frac{7}{7}\ \frac{7^{\dagger}}{7} = 40.$$

The molar teeth were of the bunodont type, their crowns being tuberculated (as in the Pigs, Mastodon and Manatee), and wearing down with use, so as to produce the characteristic double trefoil pattern (see Plate III. Fig. 5).

So far as at present known, the *Hippopotamus* is exclusively confined to the Old World, no member of the genus having as yet been met with in any Tertiary deposit on the American Continent.

We had, then, in Europe, in later Tertiary and early Quaternary times, at least two species of *Hippopotamus*, agreeing in size, and probably also in identity, with the two existing African species; whilst in India, in late Miocene or early Pliocene times, we had four species marked by differences in their dentition, and evidently belonging to an older and earlier type than the preceding.

* In *H. sivalensis* we should have incisors $\frac{3}{3}\ \frac{3}{3}$

† Or molars $\frac{6}{6}\ \frac{6}{6}$

EXPLANATION OF PLATE III.

Fig. 1. Palatal view of the skull of the recent *Hippopotamus amphibius* from Africa.

,, 2. Lower jaw of same seen from above.

(Both figures greatly reduced.)

,, 3. Palatal view of skull of *Hippopotamus sivalensis*, F. and C.

,, 4. Front or symphisial portion of lower jaw of *H. sivalensis*, showing the six incisors and the tusk-like canines.

(Both figures one-eighth natural size.)

,, 5. Molar tooth of same species, showing the worn-down double trefoil pattern of the crown (one-half natural size).

Figures 1 and 2 are taken, by permission, from Cassell's Natural History, vol. ii. p. 349, article by Prof. Boyd Dawkins and H. W. Oakley.

Figs. 3—5 are reproduced from Prof. H. A. Nicholson's Palæontology, vol. ii. p. 343, Fig. 640 (after Falconer and Cautley).

NOTICES OF MEMOIRS.

I.—Beitrag zur Kenntniss Palæozoischer Seesterne. Von B. Stürtz, in Bonn. Palæontographica, Band xxxii. 1886. Mit 7 Tafeln.

A Contribution to the Knowledge of Palæozoic Starfishes. By B. Stuertz, in Bonn. Palæontographica, vol. xxxii. pp. 75–98, pl. viii.–xiv.

Ferd. Roemer called attention [1] some years since to the echinodermal fauna occurring in the roofing slates of Bundenbach near Birkenfeld in Oldenburg, which belong to the horizon of the middle beds of the Rhenish Lower-Devonian. More particularly, Starfishes, including in the term the Asteroidea and Ophiuroidea, are abundant. The calcareous tests of these animals have been replaced by iron pyrites, and they are firmly imbedded in the hard slate in such a manner, that at the time when Roemer wrote, only the general outline of the animals could be discerned; but within the last year or two means have been found by which the slaty matrix can be entirely cleaned away, and the skeleton of the animal laid bare, so that the arrangement of the plates of the test, both on the ventral and dorsal surfaces, can be ascertained. The insight thus gained of the skeletal structure of these Devonian Starfishes has enabled Herr Stuertz to make a comparison between them and the more recent fossil and existing members of the group, and amongst other results of his work he has discovered true Ophiuroids, with a structure corresponding with that of living forms, which have not previously been known from Palæozoic strata. These were associated with the simpler Palæozoic Ophiuroids. There are also in these beds a number of true Asterids, associated with Encrinasters; and a representative of the existing genus *Astropecten*.

The single species of the *Ophiureæ veræ* belongs to the genus *Ophiurella*, Ag., and is named *O. primigenia*, St. In the group of the *Protophiureæ* are included Palæozoic Ophiuroids which possess corresponding ambulacral plates on the ventral side of the arms. The author agrees with Lütken in regarding these as doubled ventral shields, which cover the ambulacral system. In this group the author places the *Protaster Miltoni*, Salter, and *P. leptosoma*, Salter, and also a new genus, *Furcaster*, with a single species, *F. palæozoicus*, St.

Fresh observations have been made on the doubtful genus *Helianthaster*, Roemer, examples of which also occur in Devonshire as well as at Bundenbach, but they are still insufficient to determine its true position. The author regards it as an Ophiuroid Starfish with from 14–16 arms and a tolerably large disc.

The author gives the name Ophio-Encrinasteriæ to a group of forms which stand in near relationship to Ophiuroids, but possess peculiarities of structure which ally them to the Encrinasteridæ. In

[1] Palæontographica, Band ix. 1862.

addition to a new genus, *Bundenbachia*, this group also includes the genera *Tæniaster*, Billings, *Eugaster*, Hall, possibly also *Ptilonaster*, Hall, and *Protaster Forbesi*, Hall, with *Protaster Sedgwicki*, Forbes.

Under the *Asteriæ veræ*, or true Starfishes, are placed *Roemeraster asperula*, Roemer sp., *Astropecten Schlueteri*, St., *Palastropecten Zitteli*, St. n. gen. et sp., *Eoluidia Decheni*, St., n. gen. et sp., and *Protasteracanthion primus*, St. n. gen. et sp.

The following genera and species are placed in the group of the *Encrinasteriæ*: *Aspidosoma Tischbeinianum*, Roemer; *Loriolaster mirabilis*, St.; and *Palasteriscus devonicus*, St.

The species described are all figured in the accompanying plates and enlarged representations are given of their structural characters.

G. J. H.

II.—The Eocene Strata of the Krappfeld, Carinthia. By K. A. Penecke. Imper. Geol. Inst. Vienna, Meeting 17th November, 1885. Communicated by Count Marschall, F.C.G.S.

ONLY small portions of the Eocenes, resting partly on Cretaceous rocks and partly on Palæozoic schists, have escaped denudation. In one of these patches, the succession (upwards) is—

1. Lower red clays, with gravelly beds and conglomerates. 2. Modiola-marls, with, for the most part, badly preserved remains; *Modiola*, sp. (compare *crenella*, Desh.), is the most frequent. 3. Two or three seams of bright coal, with bituminous shales, containing brackish-water shells as *Faunus combustus*, Brongn., *F. undosus*, Brongn., *Melanopsis*, sp., *Planorbis*, sp., and *Cytherea Lamberti*, Desh. 4. Gasteropod-marls; similar to the foregoing marls, and abounding with well-preserved shells, as *Turritella Fuchsi*, sp. nov., *Cerithium mutabile*, *C. Canavali*, sp. nov., *Natica perusta*, and *Ostrea Canavali*, sp. nov.,; together with *Nummulites contortus*, Desh., *Serpula spirulæa*, *Modiola crenella*, *Cyrena Veronensis*, *Faunus combustus*, *F. undosus*, *Fusus longævus*, etc. 5. Nummulitic Marls. Here Gasteropods are gradually being superseded by Nummulites. The prevalent fossils are: *Orbitoides Fortisii*, *Operculina Karreri*, sp.nov., *Nummulites complanatus*, *N. perforatus*, *N. Lucasanus*, *N. contortus*, *N. exponens*, *Natica Vulcani*, and *Cerithium Canavali*. 6. Nummulitic Limestones gradually coming out of the uppermost horizon of No. 5. They contain many Echinids, Molluscs, etc., as *Alveolina longa*, *Nummulites complanatus*, *N. perforatus*, *N. contortus*, *Conoclypeus conoideus*, *Echinolampas* (comp. *Suessi*), *Pygorhynchus Mayeri*, *Linthia Heberti*, *Ostrea rarilamella*, *Velates Schmiedeliana*, *Ovula gigantea*, etc. 7. Variolarius-strata. Rather thin sands, and beds of compact sandstone, full of *Nummulites variolarius*.

Some of these beds, to a greater or less extent, are wanting, or are represented by other deposits, elsewhere in the Krappfeld. At one place some fine sands occur in the uppermost horizon of the Nummulitic Marls; and they contain good specimens of *Echinanthus tumidus*, Agass., *Linthia scarabæus*, Lbe., *L. Heberti*, Cott., and *Ottiliaster pusillus*, nov. gen. et sp. A comparison of the several sections proves the existence of two special horizons in the Krappfeld Eocenes: an

upper, marine, with abundance of Nummulites, and assuming a brackish character to the north, and a lower partly brackish horizon. The fauna throughout is Lower Eocene, and has several species in common with the fauna of Ronca, and presenting some analogy to the *Sables inférieurs* of the Paris Eocenes. This fauna numbers about 85 species,—among them are 6 *Nummulites*, 4 other *Foraminifera*, 11 *Echinida*, 2 *Serpulæ*, 1 *Terebratula*, 1 *Dentalium*, 25 Bivalves, 29 Gasteropods, and 1 *Nautilus*, besides remains of Fishes and Crustaceans. The new forms are—1. *Operculina Karreri*, with conspicuous transverse ribs. 2. *Ottiliaster pusillus*, new genus of the *Echinolampas* type, the anterior ambulacra having but one series of single pores; approaching *Eolampas*, Dunc. and Slad., from Sind, India. 3. *Ostrea Canavali*, Gryphæa-like, allied to *O. cymbiola*. 4. *Arca Rosthorni*, very small, with craticulate sculpture. 5. *Corbula semiradiata*, somewhat like *Neæra radiata*, fore-part radiately ribbed. 6. *Turritella Fuchsi*, approaching *T. imbricataria*, Lamk. 7. *Natica Ottiliæ*, a small and rather indifferent form, resembling *N. Woodi*. 8. *Cheilostoma Rosthorni*, like some species from the lowermost Belgian Eocenes. 9. *Melanopsis? Reineri*; the genus uncertain, most of the specimens being crushed. 10. *Cerithium Canavali*, very near to *C. lunatum*, Mstr. 11. *Nautilus Seelandi*, very broad and inflated. 12. *Myliobates Haueri*, near to *M. goniopleurus*, Agass.

III.—The Rock-salt Formation of Wieliczka, Galicia. By J. Niezwiecki. Imp. Geol. Instit. Vienna, Meeting 17th November, 1885. Communicated by Count Marschall, F.C.G.S.

THE borings, undertaken in order to explore the supposed westward continuation of the Salt beds, gave the following results. An alluvial deposit, 1½ meter thick, covers a grey clay (partly a marl), with seams of micaceous sand, and boulders of compact marl. This clay continued to the depth of 204½ meters, and contained some few stalks and leaves of plants, with Foraminifera (*Globigerina*, *Polymorphina*, and *Truncatulina*). This may be regarded as an eastward continuation of the sulphuriferous deposits of Swoszowice, which likewise has terrestrial plant-remains and marine shells. Coarser sand, or friable sandstone, with thin intercalations of clay, fibrous gypsum, and pieces of anhydrite, continues from 204½ to 210 meters depth. Between this and the present depth of the bore (227½ meters), saliferous clay, with scattered granular rock-salt, gypsum, and anhydrite, was pierced. Water drawn from this depth was highly saturated with salt.

IV.—Geological Formations in Afghanistan. By C. L. Griesbach, F.G.S. Imper. Geol. Inst. Vienna, Meeting 3rd November, 1885. Communicated by Count Marschall, F.C.G.S.

1. PLIOCENE. Sandstones and loose sands, with great deposits of loess, and badly-preserved Mammalian remains. 2. Pliocene. Red and light-coloured clays, with beds of loess and gypsum. Nos. 1 and 2 may be equivalent to the Manchhar and Siwalik Formation

of India. 3. Miocene (and Eocene?). Thick deposits of green and red clays, with friable limestones, and salt-beds. Miocene fossils in the upper horizons. 4. Cretaceous. Inoceramus-beds, marls (mostly variegated), and limestones with Cretaceous fossils. Marine limestones abounding in organic remains. 5. Jurassic and Lias. Light-coloured sandstones and grit, with marine limestones, and plant-remains. 6. Triassic. "Red-grit Group;" an enormous assemblage of red sandstones, conglomerates, breccias, and volcanic tuffs, with intercalated eruptive rocks (mostly melaphyres), and several horizons of Brachiopod limestones. 7. Permian. Green and grey schists, sandstones and conglomerates, with "Boulder-beds," thin coal-seams and imperfect impressions of plants S.E. of Herat and in Khorassan, alternating with hard limestones, containing Brachiopods, Conchifera, and Fusulinæ. Nos. 5, 6, and 7 may possibly correspond to the Gondwana Formations of India. 8. Carboniferous (and Devonian?). Very thick, compact, grey limestones, with subordinate shales, containing *Fenestella*, *Productus semireticulatus*, *Athyris Royssyi*, etc., in the upper horizons. No. 8, answering to the Kulling strata of Cashmere, constitutes the lowermost horizon in the large folds of the Davendar, Doshatch, Bizd, and other mountain-chains.

V.—Atmospheric Dust. By Dr. M. Schuster. Imper. Acad. Vienna, Meeting 14th January, 1886. Communicated by Count Marschall, F.C.G.S.

THIS dust was collected at Klagenfurt in Carinthia, after a rain of muddy substance, which had taken place on the 14th October, 1885. The chief constituents of the dust are minute fragmentary crystalline granules and flakes of the following minerals:—quartz, opal, orthoclase, biotite, phlogopite, pyroxene, amphibole, light-coloured mica, talc, kaolin, chlorite, rutile, anastase, zircon, tourmaline, ferruginous clay, spinel, magnetite, pyrites, magnetic pyrites, calcite, magnesite, ferruginous dolomite, and apatite. The presence of metallic iron could not be ascertained. The microscope showed a prevalence of siliceous, silicified, and calcareous remains of organisms, especially of Diatomaceæ, either in single or in pairs, together with a few carbonaceous or carbonized substances, such as the spores of Fungi and such like, filaments of Algæ and other plants, silicified membranes of parenchymal cellules, and pyritized and silicified spherules, resembling pollen. This dust bears a great general resemblance to the atmospheric dusts described by Ehrenberg and Silvestri. The reddish-yellow colour, which it has in common with the "Passat" dust, may be an objection against its having come direct from the Sahara.

[Compare the results of Prof. Judd's examination of Nile mud, Proc. Roy. Soc. vol. xxxix. No. 240, p. 216, Nov. 1885.]

REVIEWS.

I.—A Monograph of the British Stromatoporoids. By H. Alleyne Nicholson, M.D., D.Sc., etc., Regius Professor of Natural History in the University of Aberdeen. Part I. General Introduction, pp. iii. and 130, with 11 Plates. (Palæontographical Society's Volume for 1885.)

THE nature and systematic position of the widely-distributed groups of Palæozoic fossils, known generally as the Stromatoporæ, now styled by Prof. Nicholson "Stromatoporoids," have given rise to very varied differences of opinion, ever since the first genus was described by Goldfuss in 1826. The group has been alternately regarded as belonging to Foraminifera, Sponges, Polyzoa, Corals, and finally to Hydrozoa. Such diversities of opinion have not merely been maintained by those earlier authors, whose knowledge of the organism was limited to its form and other external features, but they have been also held by later investigators, who have studied its microscopic characters in thin sections. The opposing views may be to some extent explained by the different appearances presented by the fossils under different conditions of fossilization, by limited investigation, and in no small degree by the influence of previous lines of study on the part of the respective authors. Thus, for instance, Sir J. W. Dawson finds certain structures in Stromatoporoids resembling those in the supposed Foraminifer, *Eozoon Canadense*, and dismisses almost with contempt the view of Mr. H. J. Carter that *Stromatoporæ* are skeletons of hydroids allied to *Hydractinia*. This latter view is, however, now generally received; whilst Sir J. W. Dawson's opinion[1] that "*Stromatopora* and *Eozoon* may both be regarded as large, sessile, laminated calcareous Rhizopods," has not been supported by later authors. Prof. Sollas, on the other hand, places *Stromatopora* among the Vitreo-hexactinellid sponges, an opinion which was subsequently qualified by the statement that *Stromatoporæ* included organisms of very different affinities, some being siliceous sponges, some related to *Millepora* and *Hydractinia*, and some with relationships yet undetermined. Baron Rosén referred the group to Keratose sponges, in which the fibres had become silicified or calcified in fossilization. Prof. Nicholson also, in a joint memoir with Dr. Murie, reached the conclusion that the *Stromatoporæ* belonged to a peculiar extinct group of Calcisponges. To Mr. H. J. Carter belongs the credit of having first indicated the relationship of the *Stromatoporoids* to the recent *Hydractinia*, and their extinct allies, and this view has gradually been adopted by palæontologists generally.

The difficulties attending the study of this group of fossils may readily be inferred from the various opinions held with respect to their characters, and the present attempt to overcome the obstacles which have baffled previous observers implies no small amount of courage on the part of the author. The only sure method of investi-

[1] Quart. Journ. Geol. Soc. vol. xxxv. 1879, p. 50.

gation rests on the study of the minute structure of the skeleton, and this can only be known by means of thin microscopic sections. Of these, the author states that he has made considerably over a thousand with his own hands, whilst most of the specimens were collected by himself, from the Palæozoic strata of this country, North America, Germany, and Russia. By thus comparing the microscopic characters of all, or nearly all, the known forms of the group, under the different conditions of mineralization, it has been possible to obtain a more complete knowledge of these organisms than heretofore, and many features of importance, both as regards the structure and relationship of the group, have been discovered.

The first part of the Monograph contains the "General Introduction," which is treated under the following heads: (I.) Historical Introduction. (II.) The General Structure of the Skeleton. (III.) Systematic Position and Affinities of the Stromatoporoids. (IV.) Sketch Classification. (V.) Families and Genera of the Stromatoporoids. (VI.) The Nature of *Caunopora*.

(I.) Under the first head an account is given in chronological order of the various memoirs on the group. From this we learn that the type-specimen of *Stromatopora concentrica*, Goldf. (now preserved in the Bonn Museum), which is the type species of the genus, exhibits a structure greatly different from that which has generally been regarded by palæontologists as characteristic of the genus *Stromatopora*. The typical figured specimen of Goldfuss is a large mass of numerous thick concentric strata ("latilaminæ"), more or less undulating, from 1·5 to 3 mm. in thickness, and separated by narrow interspaces. Microscopic sections show that the skeleton is essentially a complex net-work of anastomosing calcareous fibres, so disposed as to inclose correspondingly complex anastomosing canals. The minute characters of this typical form had not previously been subjected to microscopical examination, and consequently the forms assigned to the genus by Bargatzky, Carter, and others, which possess structures of a different character, must necessarily be included in a new genus, which the author proposes to name *Actinostroma*, and which forms the type of the group *Actinostromidæ*.

(II.) Treating of the general structure of the skeleton of the Stromatoporoids, the author states that the typical form is that of a hemispherical mass or a flattened expansion, attached by a narrow peduncle, or directly to some foreign body, but having the under surface covered by a concentrically wrinkled imperforate epitheca, while the apertures for the emission of the polypites are carried upon the upper surface. Certain forms are ramose or dendroid, and some habitually encrust other organisms. The skeleton was originally of granular carbonate of lime, probably in the form of arragonite, but this is now replaced occasionally by silica and by crystalline calcite. One distinctive feature of the whole group of the Stromatoporoids is the constitution of the skeleton of superimposed concentric layers. In some cases these are very thick, strata-like, and made up of a series of vertical rods ("radial pillars"), which run from the top to the bottom of the stratum, and

are united at irregular intervals by oblique or horizontal processes. Between the vertical rods are the tortuous, tubular, and often tabulate, canals, in which the zoöids were lodged. In other cases, the skeleton is made up of numerous closely-approximated concentric laminæ, not in absolute contact, but separated by interlaminar spaces, which are intersected by vertical columns or "radial pillars," which connect the laminæ, and may pass through several laminæ and interspaces. The calcareous fibres of the skeleton are probably in no case compact, sometimes they are filled with what appear to be minute pores or vesicles, at others by complex ramifying tubuli. Nothing of the nature of definite spicules has been noticed in any example of the group.

According to the general arrangement of the "radial pillars" and "concentric laminæ" two principal sections of Stromatoporoids are distinguished, the Milleporoid and Hydractinioid sections. In the first of these, represented by the genus *Stromatopora*, Goldfuss, the radial pillars and concentric laminæ are completely amalgamated, and, as a rule, cannot be recognized as distinct structures. Tangential sections of the skeleton appear to be continuously reticulate, resembling that of *Millepora*, whilst in vertical sections the radial pillars appear as thick, irregular and flexuous, and the concentric laminæ are only represented by irregular lateral outgrowths, which spring from the pillars and unite them into a continuous framework. In the "Hydractinioid" section, represented by the genus *Actinostroma*, the radial pillars and concentric layers are present as distinct, though closely connected structures. In vertical sections of *A. clathratum*, the skeleton appears as a series of parallel vertical rods, nearly equi-distant from each other and connected at regular intervals by a series of parallel horizontal laminæ. In a tangential or horizontal section, the transversely-divided ends of the radial pillars appear as rounded or stellate dots, placed at tolerably regular intervals. The radial pillars give out at regular intervals, verticils of horizontal connecting processes or arms, which join one another to form a complete network, and the concentric laminæ are, in reality, formed of these united horizontal processes. When the section passes through the plane of one of the concentric lamina, the cut ends of the radiate pillars have a stellate form, and their united arms form an angular mesh-work, not unlike that of a hexactinellid sponge, but if the section is through the interlaminar spaces, then only the cut ends of the radial pillars are visible. Thus the concentric lamina is, in reality, merely a porous mesh-work, through the openings of which in the upper layer the zoöids could extend.

In the genus *Clathrodictyon*, Nich. and Murie, the radial pillars are incomplete or almost obsolete, whilst in *Labechia* they are highly developed. The author states that the radial pillars are not invariably solid, a minute central canal can be detected in many, but even where this exists, it does not appear to have been open at the summit. There is no ground for the supposition that the pillars were inhabited by zoöids, or that they can be compared in any way with the zoöidal tubes of *Millepora*. In one singular form, *Hermatostroma*

Schluteri, there are large canals in the radial pillars, which send out branches into the connecting processes forming the concentric lamina, and this fact indicates that the fibres of the concentric lamina generally may be hollow.

One obstacle to ranging the Stromatoporoids with the *Cœlenterata* has been the apparent absence of any tubes for the lodgment of the zoöids, but the author has made the important discovery that the skeleton of the typical *Stromatoporæ* is penetrated by numerous minute, flexuous, but essentially parallel, vertical tubes, which are not bounded by definite walls, but simply inclosed by the vermiculate fibres of the cœnosteum, precisely like the zoöidal tubes in *Millepora*. Further, these tubes are traversed at intervals by calcareous plates, similar to those of *Millepora* and tabulate corals. These tabulate zoöidal tubes can be clearly distinguished in different species of *Stromatopora*, and also in such genera as *Idiostroma*, Winch., and *Stachyodes*, Barg. Definite tubes are not clearly recognizable in the Hydractinioid section of the group, but there are zoöidal cavities in *Actinostroma*, and in *Labechia* it is probable that the zoöids were given off from the surface layer of the cœnosarc.

The author agrees with Mr. Carter in recognizing the stellate canal system on the surface of the concentric laminæ as the homologue of the branching of the cœnosarcal grooves on the surface of the skeleton of many Hydractiniæ, and adopts for it Mr. Carter's term Astrorhizæ. These canals, though not invariably present, are yet found in so many different forms of the group, that they cannot be accepted as of generic value, and consequently the genus *Cœnostroma*, Winchell, in which they are regarded as an essential character, cannot be retained.

In some anomalous, cylindrical or dendroid, Stromatoporoids, placed in the genera *Idiostroma*, *Amphipora*, and *Stachyodes*, there is a central, axial, tabulated tube, without proper wall, giving off at times lateral branches, which also divide. These "axial tubes" are quite distinct from those of the so-called *Caunopora*, and the author thinks they may have lodged a stolon or axis of the cœnosarc, and that the smaller lateral tubes may have been occupied by a special series of zoöids.

Certain large-sized lenticular vesicles, resembling the "ampullæ" of the recent *Stylasteridæ*, are present in *Amphipora ramosa*, Phill. sp., and may probably have lodged the reproductive zoöids, and large tabulated vesicles in *Idiostroma capitatum*, Goldf. sp., may also have served for the same purpose.

(III.) *Systematic Position and Affinities.*—The author frankly accepts the views of Carter, Lindström, Zittel, and others as to the cœlenterate affinities of the Stromatoporoids, and regards them as a special group of the *Hydrozoa*, having relationships on the one hand with *Hydractinia*, and on the other with *Millepora*. A detailed comparison between *Hydractinia echinata*, Flem., and forms of *Actinostroma*, Nich., shows that there is a remarkable similarity between the minute structure of the chitinous skeleton of the former organism and the large calcareous cœnosteum of the latter; and a similar but

not so striking a resemblance is also seen when the comparison is made with the *Hydractinia circumvestiens* from the Red Crag of Suffolk, which possesses a calcareous cœnosteum. The typical Stromatoporæ, on the other hand, are more closely comparable with the cœnosteum of *Millepora*. But as both the groups of Stromatoporoids are linked together by intermediate forms, and thus constitute a natural series, it is better to retain these fossils as a peculiar division of the *Hydrozoa*

(IV.) *Sketch Classification.*—This is to be accepted as largely tentative, as many of the types have not yet been properly examined. The following tabular view is given by the author.

Order.—Stromatoporoidea, Nich. and Murie.

Section A. ("Hydractinioid" Group).

Fam. 1. Actinostromidæ, Nich.

Genera—*Actinostroma*, Nich.; *Clathrodictyon*, Nich. and Murie; *Stylodictyon*, Nich. and Murie (?).

Fam. 2. Labechiidæ, Nich.

Genera—*Labechia*, E. & H.; *Rosenella*, Nich.; *Beatricea*, Bill. (?); *Dictyostroma*, Nich. (?).

Section B. ("Milleporoid" Group).

Fam. 3. Stromatoporidæ, Nich.

Genera—*Stromatapora*, Goldf.; *Stromatoporella*, Nich.; *Parallelopora*, Barg. (sub-genus ?); *Syringostroma*, Nich. (sub-genus ?).

Fam. 4. Idiostromidæ, Nich.

Genera—*Idiostroma*, Winch.; *Hermatostroma*, Nich.; *Amphipora*, Schulz; *Stachyodes*, Barg.

(V.) *Families and Genera of the Stromatoporoids.*—Detailed descriptions are given of the characters of the various members of the group, to which space prevents further reference, but the inclusion of the peculiar forms known as *Beatricea*, Bill., as a genus of Stromatoporoids, calls for some notice. These fossils are cylindrical or angulated rods or stems, often of considerable size, some reaching 10 feet in length by one foot in thickness. They possess a central, relatively large, axial canal, without definite walls, and divided by superposed, curved, tabulæ. Between the central canal and the exterior of the fossil, the skeleton consists of concentric layers of vesicular tissue. The position of these fossils has long been regarded as uncertain, and one observer, Prof. Hyatt, who formerly referred the genus to the *Cephalopoda*, now degrades it to the *Foraminifera*. The general opinion has been in favour of its alliance to the Cystiphylloid Corals. The fossils are generally very imperfectly preserved, but Prof. Nicholson has detected, in some specimens, structures radiating from the central canal towards the circumference, which he regards as "radial pillars" essentially similar to those of the genus *Labechia*. The axial tabulate tube is regarded as parallel with the tubes in *Idiostroma*, *Stachyodes*, and *Amphipora*. But the axial tubes in these forms are so much smaller than those of *Beatricea*,

that whilst it may seem reasonable to suppose that the former were occupied by a stolon or axis of the cœnosarc, the same explanation will hardly suffice for the latter, in which the axial canal is sometimes 10 mm. in diameter. On the whole, whilst fully appreciating the significance of the facts brought forward by Prof. Nicholson, we should feel disposed to wait for further evidence before definitely accepting *Beatricea* as a genus of Stromatoporoids.

(VI.) *The Nature of Caunopora.*—The author discusses in detail the much-debated subject of the nature of the Stromatoporoids, in which the cœnosteum is traversed by thick-walled tubes at right angles to the concentric laminæ of the fossil. These tubes are frequently tabulate, and in some cases they possess spines resembling the spinal septa of *Favosites* or *Syringopora*, and they are usually all connected together and open into each other, whilst at the same time no communication can be traced between them and the interlaminar spaces of the *Stromatopora* itself. Prof. Nicholson has established the fact that in several distinct species of *Stromatopora* and *Stromatoporella*, there are two states of the same species occurring in the same locality, one, in which the so-called "*Caunopora*" tubes are present, and the other in which these structures are entirely wanting. It follows from this, that the existence of these tubes can in no wise characterize a particular genus, and therefore the names of *Caunopora*, Phill., and *Diapora*, Barg., must be abandoned.

In character these "Caunopora" tubes closely resemble the tubes of *Syringopora* and *Aulopora*, and by Rœmer, Carter, and others they are believed to be independent organisms enveloped in the growth of the Stromatopora. There are certain difficulties against the acceptance of this theory; one is the fact, that many of these tubes are not known independent of their Stromatopora envelopment. The "Caunopora" tubes often occur also in localities where independent forms of *Syringopora* are altogether absent, and on the other hand, where the corals are abundant, the "Caunopora" forms of Stromatopora are rare. It is possible that, owing to the commensal mode of growth, distinct forms of *Syringopora* and *Aulopora* may have been produced. The author arrives at the conclusion that "the fossils ordinarily called '*Caunoporæ*' and '*Diaporæ*' are the result of the combined growth of some Stromatoporoid with some Coral, the former usually being a species of *Stromatopora* or *Stromatoporella*, and the latter generally belonging either to *Syringopora* or to *Aulopora*."

In concluding this notice, we may call attention to the beautiful plates in which the minute structures of the organisms described are fully illustrated. The plates have been drawn by the author and lithographed by Mr. Hollick. This first part of the Monograph needs no commendation. It is a very important contribution to the knowledge of a most puzzling group of organisms, and the subject is treated with that thoroughness which specially characterizes Prof. Nicholson's work. G. J. H.

II.—Report on the Invertebrata of the Laramie and Cretaceous Rocks of the North-west Territory. Contributions to Canadian Palæontology. By J. F. Whiteaves, F.G.S., etc. Palæontologist and Zoologist to the Survey. Vol. I. Part 1. 8vo. pp. 89 and 6 Plates. (Montreal, Dawson Bros., 1885.)

UNDER the title of 'Contributions to Canadian Palæontology,' it is proposed to publish such papers as cannot be conveniently included in either of the volumes on the Palæozoic or Mesozoic Fossils of Canada, now in course of preparation. This first part contains a determination of the marine, brackish, and freshwater invertebrate fossils —with one exception, all mollusca—collected by Dr. G. M. Dawson and others in the North-west Territory of Canada. Many of these fossils have already been described by Messrs. Meek and Hayden and other United States palæontologists, and of these reference is made to the synonymy, and the localities are given where they occur. The new forms are fully described and figured. They include *Unio Albertensis*, *Anomia perstrigosa*, *Corbicula obliqua*, *C. perangulata*, *Panopæa simulatrix*, *P. curta*, *Acella*, sp., *Physa Copei*, var. *Canadensis*, *Acroloxus radiatulus*, *Patula angulifera*, *P. obtusata*, *Anchistoma parvulum*, *Valvata filosa*, *V. bicincta*, *Gervillia recta*, var. *borealis*, *Modiola dichotoma*, *Cyprina ovata*, var. *alta*, *Protocardia borealis*, *Panopæa subovalis*, *Scaphites subglobosus*, *Crenella* (?) *parvula*, *Unio supragibbosus*, *Rhytophorus glaber*, *Planorbis paucivolvis*, *Hydrobia subcylindracea*, and the solitary Crustacean *Hoploparia? Canadensis*.

The rocks from which these fossils have been obtained are fully described by Dr. G. M. Dawson in the Report of Progress of the Geological Survey of Canada, 1882–4. In the Laramie Group are included, (1) Porcupine Hill beds, of freshwater sandstones and shales —2500 feet; (2) Willow Creek beds, also freshwater—450 feet; (3) St. Mary River Series, nearly all freshwater—2800 feet; thus making a total thickness of 5750 feet of strata assigned to the Laramie Group. In the underlying (so-called) Cretaceous series the following subdivisions are made: (*a*) Fox Hill Sandstones, brackish-water, 80 feet; (*b*) Pierre shales, marine, 750 feet; (*c*) Belly River series, 910 feet; (*d*) Lower dark shales, 800 feet; in all a total thickness of 2540 feet. The stratigraphical disposition adopted by Dr. G. M. Dawson of a Cretaceous series and an upper series—the Laramie—of extra Cretaceous rocks, is not, according to Mr. Whiteaves, supported by the palæontological evidence. This author states that the "invertebrate fauna of the 'Belly River series' seems to be essentially the same as that of the Laramie of the United States and Canada, unless more than one formation has been confounded under the latter name, and that it is at present scarcely possible to separate the 'Lower Dark Shales' of Dr. Dawson's Report from the 'Fort Pierre and Fox Hill Groups' on purely palæontological grounds." If this statement is correct, that the fossils of these two important series of strata are similar, it would be interesting to know the reasons which have led to the separation of the Laramie division from the Cretaceous in Canada.

G. J. H.

III.—Publications of the Palæontograpical Society, London. 4to. Vols. XXXIII.—XXXIX., 1879—1885. President: Sir Richard Owen, K.C.B., M.D., D.C.L., LL.D., F.R.S., F.G.S., etc. Secretary: Professor T. Wiltshire, M.A., F.G.S., 25, Granville Park, Lewisham. S.E. Treasurer: Robert Etheridge, Esq., F.R.S., F.G.S., British Museum (Natural History), Cromwell Road, S.W.

THE Palæontographical Society was established in the year 1847, for the purpose of figuring and describing the *whole* of the British fossils. Each person subscribing One Guinea is considered a Member of the Society, and is entitled to the Volume issued for the year to which the subscription relates.

Surely this is a Society that has the highest possible claims upon the consideration of every geologist, who must, as a matter of course, be deeply interested in the past Life-history of the Earth whose crust he is bound, hammer in hand, to explore,

It seems rather surprising that only 475 Members should at present be found willing to subscribe an annual guinea for so grand a publication, one which, in a mere mercantile sense, is *richly worth two guineas*, in a scientific point of view, would be cheap at four guineas a year!

The following is a summary of the contents of the last seven volumes issued:—

Vol. XXXIII. for the year 1879, contains:—

The Eocene Flora, Part I. by Mr. J. S. Gardner and Baron Ettingshausen, 5 plates.—Second Supplement to the Crag Mollusca (Univalves and Bivalves), by Mr. S. V. Wood, 6 plates. (Complete with Title page and Index).—The Fossil *Trigoniæ*, No. V. (*Conclusion*), by Dr. Lycett, 1 plate.—The Lias Ammonites, Part II. by Dr. Wright, 10 plates.—Supplement to the Reptilia of the Wealden (*Goniopholis*, *Brachydectes*, *Nannosuchus*, *Theriosuchus*, and *Nuthetes*, No. IX. by Prof. Owen, 4 plates.—The Fossil Elephants (*E. primigenius*), Part II. by Prof. Leith Adams, 10 plates.

Vol. XXXIV. for 1880, comprises:—

The Eocene Flora, Part II. by Mr. J. S. Gardner and Baron Ettingshausen, 6 plates.—The Fossil Echinodermata, Oolitic, Vol. II. Part III. (Asteroidea and Ophiuroidea), by Dr. Wright, 3 plates. (Complete).—Supplement to the Fossil Brachiopoda, III. (Permian and Carboniferous), by Mr. Davidson, 8 plates.—The Lias Ammonites, Part III. by Dr. Wright, 22 plates.—The Reptilia of the London Clay, Vol. II. Part I. (*Chelone*) by Prof. Owen, 2 plates.

Vol. XXXV. for 1881, embraces:—

The Fossil Echinodermata, Cretaceous, Vol. I. Part IX. by Dr. Wright, 6 plates.—Supplement to the Fossil Brachiopoda, Part IV. (Devonian and Silurian, from Budleigh-Salterton Pebble Bed), by Dr. Davidson, 5 plates.—The Fossil Trigoniæ (Supplement to No. 1), by Dr. Lycett.—The Lias Ammonites, Part IV. by Dr. Wright, 10 plates.—The Reptilia of the Liassic Formations, Part III. (*Conclusion*), by Prof. Owen, 13 plates.—The Fossil Elephants (*E. primigenius* and *E. meridionalis*), Part III. (*Conclusion*), by Prof. Leith Adams, 13 plates.

Vol. XXXVI. for 1882 includes:—

The Eocene Flora, Vol. I. Part III. (*Conclusion*), by Mr. J. S. Gardner and Baron Ettingshausen, 2 plates.—Third Supplement to the Crag Mollusca, by the late Mr. S. V. Wood, 1 plate. (Complete).—The Fossil Echinodermata, Cretaceous Vol. I. Part X. (*Conclusion*), by Dr. Wright, 5 plates.—Supplement to the Fossil Brachiopoda, Vol. IV. Part V. (*Conclusion*), by Dr. Davidson.—Supplement to the Fossil Brachiopoda, Vol. V. Part I. (Devonian and Silurian), by Dr. Davidson, 7 plates.—The Lias Ammonites, Part V. by Dr. Wright, 22 plates.

Vol. XXXVII. for 1883, contains :—

The Eocene Flora, Vol. II. Part I. by Mr. J. S. Gardner, 9 plates.—The Trilobites of the Silurian, Devonian, &c., Formations, Part V (*Conclusion*), by the late Mr. J. W. Salter.—The Carboniferous Trilobites, Part I. by Dr. H. Woodward, 6 plates.—Supplement to the Fossil Brachiopoda, Vol. V. Part II. (Silurian), by Dr. Davidson, 10 plates.—The Fossil Trigoniæ (Supplement No. 2), by the late Dr. Lycett, 4 plates. (Complete).—The Lias Ammonites, Part VI. by Dr. Wright, 8 plates.

Vol. XXXVIII. for 1884, comprises :—

The Eocene Flora, Vol. II. Part II by Mr. J. S. Gardner, 11 plates.—The Carboniferous Entomostraca, Part I. No. 2 (*Conclusion*), by Prof. T. Rupert Jones, Mr. J. W. Kirby, and Prof. G. S. Brady, 2 plates.—The Carboniferous Trilobites, Part II. by Dr. H. Woodward, 4 plates. (*Conclusion*).—Supplement to the Fossil Brachiopoda, Vol. V. Part III. (*Conclusion*), by Dr. Davidson, 4 plates.—The Lias Ammonites, Part VII. by Dr. Wright, 10 plates.

Vol. XXXIX.* for 1885, embraces :—

1. The Eocene Flora, Vol. II. Part III. (*Conclusion*), by Mr. J. S. Gardner, F.G.S., with 7 plates.—2. The Stromatoporoids, Part I. by Prof. H. Alleyne Nicholson, M.D., D.Sc., F.R.S.E., F.G.S., with 11 plates.—3. The Fossil Brachiopoda (Bibliography), Vol. VI. (*Conclusion*). by the late Dr. Davidson, F.R.S., and Mr. W. H. Dalton, F.G.S.—4. The Lias Ammonites, Part VIII. (*Conclusion*), by the late Dr. Wright, F.R.S., with 1 plate.

From this it will be seen that seventeen Monographs are brought to a conclusion and have their Indices and Title-pages provided for them; whilst fresh Monographs are announced as in progress, On the Fossil Tertiary Plants, by J. Starkie Gardner, F.G.S.—On the Coal-Plants, by Prof. Williamson, F.R.S., of Manchester.—On the Stromatoporoids, by Prof. H. Alleyne Nicholson, M.D., F.R.S.E.,† etc.—On the Fossil Sponges, by Dr. G. J. Hinde, F.G.S.—On the Gasteropoda of the Jurassic Rocks, by Wilfrid H. Hudleston, M.A., F.R.S., F.L.S., F.G.S.—On the Oolitic Cephalopoda, by Mr. J. Buckman.—On the Phyllopoda of the Palæozoic rocks, by Professor T. Rupert Jones, F.R.S., F.G.S.—On the Entomostraca of the Cretaceous formation, by Prof. T. Rupert Jones, F.R.S., F.G.S., and Dr. G. J. Hinde, F.G.S.—On the Trilobita of the Silurian and Cambrian formations, by Henry Woodward, LL.D., F.R.S., F.G.S., and On British Fossil Malacostraca, by the same author.—The Graptolites of the Cambrian and Silurian formations, by Prof. Charles Lapworth, LL.D., F.G.S., etc.—The Fishes of the Carboniferous Formation, by Dr. R. H. Traquair, F.R.S., F.G.S., etc.

Other Monographs are no doubt forthcoming; but with such an attractive bill of fare for the present and future years, who, that is interested in palæontology, can withhold his subscription in support of so splendid and National a work?

REPORTS AND PROCEEDINGS.

I.—Royal Geological Society of Ireland. (Abstract.)

At the Anniversary Meeting on the 17th inst. (February) a paper was read by Mr. A. B. Wynne, F.G.S., "On some recent discoveries of interest in the Geology of the Punjab Salt Range."

* Completed and ready for issue on February 15th, 1886. † See ante, pp. 123–128.

The author refrained from attempting any lengthened treatment of so large a subject as the geology of this region, having already contributed various reports and papers to the mass of information existing in some forty publications which formed the geological literature of the Range during the last fifty-seven years. Of these numerous publications, some, if not absolutely mythological, trenched largely upon the limits of romance; some, like Dr. Fleming's, were most valuable records of close scientific observation; and others, such as Dr. Jameson's, possessed historic interest, and showed the difficulties under which the pioneers of geological research explored that country. This officer related how—in his progress through the then native territory of the Salt Range, etc., in order to investigate the causes of those *debacles* which sometimes carry devastation along the course of the Upper Indus towards the Plains—his party was beset in the Kotul Pass in the year 1841, his followers killed, and his personal effects and MS. notes all plundered by Afrídí robbers, he himself escaping with his life only to be imprisoned in the fort at Kohát.

Some reference to the position, etc., of the Salt Range was necessary, in order that people at this distance from that locality—some 5000 to 6000 miles—might more readily comprehend the references to be made. The Range was described as subtending that angle of Northern India embraced between the Great Himálayan and Suliman Mountains. It would almost appear to have yielded to the thrust from these vast masses at each end so as to have assumed curvature amounting to sigmoid flexure along the strike, in the effort to adapt itself, so to speak, to restricted limits; while its geological series forming a semi-anticlinal arch, as a dominant feature, presented a grand façade of precipices with a general height of 2000 feet, and a culminating one of over 5000 feet above the sea; overlooking the plains and deserts to the south, and rising from amongst chaotic masses, the wreckage and ruins of their own materials. On the north it sloped more gently beneath the elevated steppe-like plateau of Rawul Pindi, this having a height of 1600 to 1700 feet above sea-level.

The range possesses interest geologically, as affording almost the only opportunity of studying an extensive series, embracing groups belonging to nearly all the chief periods from early Palæozoic to later Kainozoic time; geographically interposed between the remarkably dissimilar geological areas of Peninsular India and the Himálaya, each of which had a geological history peculiarly its own. But the Salt Range was also important by reason of the great value of its inexhaustible mineral resources; its 500 feet of rock salt beds, traceable for 130 miles, producing an increasing annual revenue, some years since estimated at over £382,650 sterling; resources which now require a special branch railway and bridge across the River Jhélum (the ancient Hydaspes) to transport the salt.

Certain varieties in the relative fullness of the sections displayed at the centre and at each end of the Range were described, such as

the limitation of the "Carboniferous or *Productus* Limestone" to the west of the Range: a formation also remarkable for its having afforded the earliest known *Ammonite* and the peculiar Brachiopoda *Lyttonia* and *Oldhamini* (Waagen), found only in two other, distant, Eastern localities, one of them being in China. The last-named of these forms had been previously described as a *Bellerophon*, whilst the rugose interior aspect of the larger valves of *Lyttonia* had been regarded as fish teeth.

Attention was called to the absence of any recognizable Devonian group in the Range and to the recent interesting discovery by Dr. H. K. Warth, Ph.D., Indian Public Works Department, of what are claimed to be Devonian fossils; particularly those of the genus *Conularia*; inclosed both as rolled fragments in the matrix and also in derivative pebbles, within a certain conglomerate-layer, traceable for miles in the eastern part of the Range above the Mayo Salt Mines, and included in the upper part of an olive group of rocks referred by Dr. W. Waagen and the author, when jointly classifying the Salt Range series, to a presumably Cretaceous horizon. Specimens of the *Conularia* were exhibited, which, on being compared with a published figure of *Conularia ornata* from the Devonian formation, presented a striking identity, but no published determination of these Salt Range forms was as yet known.

It was pointed out that none of the Himálayan or other neighbouring rocks (including those of the Salt Range) contained any established Devonian horizon, nor any beds with which the pebbles containing these fossils could be actually identified. Still their pale colour might suggest that they came from some part of a very pronounced group in the lower part of the series which had been called the "Magnesian Sandstone Division," resting upon the Silurian or "*Obolus* zone." The group had, however, hitherto proved quite unfossiliferous.

Turning unwillingly from this conjecture, if another origin for the pebbles were to be sought, the next most possible supposition would be that the parent rock lay to the south and belonged to a land long since buried beneath the alluvial plains and deserts which stretched southwards into Scind—a land perhaps connected with the lost continent of Lemuria, supposed to have united India with Africa.

One small group of hills called the Korana Hills projects from the plains of the Chenab river, about forty miles southward of the Salt Range; these had been visited by both Dr. Fleming and by Mr. Theobald. Their dark slaty rocks, however, as described by those gentlemen, afford no clue to the identification of the derived *Conularia* pebbles, and present no similarity either to any belonging to the Salt Range.

Instances of the occurrence of other detrital deposits in the Range, the coarse materials of which were likewise untraceable amongst the surrounding rocky tracts, were alluded to as strengthening the supposition of a lost continent to the south, which had furnished hard metamorphic detritus at various periods in the history of the Salt Range. These deposits were found immediately overlying the salt and gypseous marl at the base of the series: again near the Silurian

horizon, and in the "Olive group" with the *Conularia* layer, but lower in position. From these Mr. Theobald had obtained at least one glaciated boulder. A still newer band marked by boulders of a red granite, the source of which was quite unknown, occurred in the Tertiary beds above the Eocene Limestone of the Range.

The interest of Dr. Warth's discovery was enhanced by the conspicuous absence of known Devonian rocks among the formations of Northern India, if not from Indian series generally, and in the hope that some further determinations would be made, the specimens kindly sent from the Punjab by Dr. Warth were handed over by the author to the Museum of Trinity College, Dublin, through its Curator, the Professor of Geology, etc., W. J. Sollas, D.Sc., LL.D., who promised attention to the subject, and noted much similarity between the contents of the Salt Range Cretaceous deposits and conditions, and those of Cambridge.

II.—Belfast Natural History Society.

Mosasaurus gracilis, Owen, from the Irish Chalk.

At a meeting of the Belfast Natural History and Philosophical Society, held in their museum on Tuesday, February the 2nd, the President, W. H. Patterson, Esq., M.R.I.A., in the Chair, a short communication was brought forward by Mr. W. Swanston, F.G.S., on the occurrence of remains of *Mosasaurus gracilis*, Owen, recently presented to the Museum by Mr. Turner, Mountain Bush, in whose quarries at Whitewell the specimen was found. The fossil is portion of the caudal vertebræ, consisting of three joints attached, very closely resembling the specimen figured in the Palæontographical Society's Journ. 1851, vol. viii. fig. 3. This is the first record of the species from Irish strata. The quarries from which the specimen was obtained are in the White Limestone (Upper Chalk), most probably the zone of *Ammonites Gollevillensis*, representing, according to Professor Ralph Tate, F.G.S., the Upper Chalk of Norwich, and the "Craie de Meudon," and some of its fossils point to even a higher parallel, that of the Maestricht Chalk (Quart. Journ. Geol. Soc. London, 1865, vol. xxi. p. 36).

III.—Geological Society of London.

I.—Jan. 27, 1886.—Prof. T. G. Bonney, D.Sc., LL.D., F.R.S., President, in the Chair.—The following communications were read:

1. "On the Fossil Mammalia of Maragha, in North-western Persia." By R. Lydekker, Esq., B.A., F.G.S., etc.

The author alluded to the important memoirs of Messrs. Grewingk, Pohlig, and Rodler on the Maragha mammalia, and having expressed the hope that his notice would be regarded as an attempt to assist rather than to interfere with their work, mentioned a collection of specimens from Maragha sent by Mr. Damon to the British Museum. He fully confirmed the conclusions already arrived at as to the identity of many of the Maragha mammals with those of Pikermi, and thought that *Giraffa attica*, *Palæoryx Pallasi*, *Sus erymanthius*,

Mastodon pentelici, and *Helladotherium Duvernoyi* might be added to the list of species already recorded. He also recorded the French *Felis brevirostris*; a *Rhinoceros*, apparently allied to *R. antiquitatis*; and *R. Blanfordi*, of the north-west portion of India and China. The paper concluded with some observations regarding the relations of the Palæarctic and Oriental Pliocene faunas.

2. "On the Pliocene of Maragha, Persia, and its resemblance to that of Pikermi, in Greece; on Fossil Elephant-remains of Caucasia and Persia; and on the results of a Monograph of the Fossil Elephants of Germany and Italy." By Dr. H. Pohlig. Communicated by Dr. G. J. Hinde, F.G.S.

The principal object of the author in making a geological tour through part of Persia, in 1884, was the exploration of a deposit containing Pliocene mammals, discovered thirty years ago near Maragha, east of Lake Urumia, by Göbel and Khanikoff. The first part of the present paper gives a brief account of the results of this exploration, together with a list of the fossils.

The ossiferous deposits near Maragha are of fluvio-lacustrine origin, and consist chiefly of reddish marls, similar to those of Pikermi, and formed from the detritus of the volcanic mountain of Sahend. These Pliocene beds rest upon horizontal Cretaceous strata, and pass upwards into Pleistocene deposits with erratic blocks.

In the list of fossil mammalia it is shown that several are the same as Pikermi forms. A *Hipparion*, probably identical with *H. gracile*, is the most abundant. The supposed occurrence of Pleistocene forms, such as *Rhinoceros tichorhinus*, associated with the Maragha Pliocene fossils, is probably an error.

The second part of the paper contains notes on specimens of *Elephas primigenius*, chiefly in the Museum of Tiflis. The third part gives very briefly the principal results of the author's examination of Pleistocene *Proboscidea* in the various museums of Europe, especially in those of Germany and Italy, and concludes with his views with respect to *Elephas antiquus*, *E. melitæ* (which he considers a dwarf form of *E. antiquus*), *E. meridionalis*, *E. hysudricus* (which the author considers identical with *E. meridionalis*), *E. primigenius*, and a few other species, one of which is believed to be new.

3. "The Thames Valley Surface-deposits of the Ealing District and their associated Palæolithic Floors." By John Allen Brown, Esq. Communicated by A. Ramsay, Esq., F.G.S.

The author stated that his paper might be regarded as in some degree supplementary to that by Colonel Lane-Fox, published in the Quarterly Journal of the Society in November, 1872. He referred to Mr. Whitaker's division of the Thames-valley deposits into three terraces, namely:—1. The lowest now seen in bends of the river, 10–20 feet above O. D.; 2. The middle terrace, 20–40 feet; and 3. The high-terrace gravel, 50–100 feet, extending up to the shoulders of the hills, and, according to the author, much higher. The high-terrace gravels near Ealing reach nearly to the top of the hills forming the inner valley-ridge, the highest point in which is the Mount at Ealing, 204 feet. The summit of this, when excavated

for a reservoir, was found to be occupied by thick beds of gravel of different character from the valley-gravels, and not of fluviatile or estuarine formation; the same gravel occurs upon other elevations, and patches of it, appearing here and there, show that it probably once extended right along the ridge and over Hanger Hill. Similar materials to those forming this gravel also occur scattered over the surface of the ground. On the Mount these gravels filled a series of furrows or channels, beneath which were horizontally stratified deposits of white sand, loam, and loamy clay, which were pressed out of the line of deposit where the jagged furrows occurred; and from all the characters presented the author inferred that these deposits were due to the action of ice which had stranded and melted here, and deposited its burthen of glacial detritus. The author described the deposits of gravels, brick-earth, etc., at various points in the district, and noticed that the high-terrace gravels between 60 and 125 feet contain seams of black matter, apparently due to the decay of vegetable substances, which recur at more or less regular intervals, and serve to indicate three or four lines of old land-surfaces. In connexion with these land-surfaces, especially in some pits excavated in the Creffield Road, about 100 feet above O. D., numerous worked flints were found, the characters and mode of association of which led the author to think that we have here traces of a regular manufactory of flint implements. He further indicated the conditions under which he considered their preservation in this locality had taken place.

II.—Feb. 10, 1886.—Prof. T. G. Bonney, D.Sc., LL.D., F.R.S., President, in the Chair.—The following communications were read:

1. "On a new species of *Psilotites* from the Lanarkshire Coal-field." By R. Kidston, Esq., F.G.S.

The specimen described, which was found by Mr. Walter Burns in 1884, consists of three parallel branchlets with thorn-like projections on one side only. The author describes these as a form of Goldenberg's genus *Psilotites*, and points out that they have much resemblance to Dawson's *Psilophyton*.

2. "The Melbourn Rock and the Zone of *Belemnitella plena*, from Cambridge to the Chiltern Hills." By W. Hill, Esq., F.G.S., and A. J. Jukes-Browne, Esq., F.G.S.

The "Melbourn Rock," which was first defined by one of the authors in 1880, is a band of rocky chalk which forms the base of the Middle Chalk in Cambridgeshire, and occurs about 80 feet above the "Totternhoe Stone." In the present paper it was shown, as the result of the mapping operations of the Geological Survey, to form a well-marked and constant feature in the counties of Hertford, Bedford, Buckingham, and Oxford. In the original description of the Melbourn Rock it was confounded with the "Zone of *Belemnitella plena* in a *remanié* condition," as described by Dr. Barrois; but it was now pointed out that the latter horizon is distinct from and underlies the latter. Although the zone of *Belmnitella plena* has been very largely removed by erosion in the district described, there is,

nevertheless, evidence that this erosion has gone on to a different extent in each of the localities which have been particularly studied; and in some places some of the lower portions of the rocks of that horizon seem to have escaped denudation.

The microscopical characters of the several varieties of rock forming the Lower and Middle Chalk of the district were described, and it was shown that the beds containing nodules of a different variety of chalk which occur below the Melbourn Rock, may have been formed by the washing away of the finer particles from a disintegrating mass of chalk. This mottled chalk and the overlying Melbourn Rock are very similar to the bed found on the same horizon in the Richmond well. Somewhat similar beds occur, however, at other horizons in the Chalk over the district described in this paper.

3. "On the Beds between the Upper and Lower Chalk of Dover, and their comparison with the Middle Chalk of Cambridgeshire." By W. Hill, Esq., F.G.S.

In introducing the subject of this paper, the author referred to the divisions of the Upper Cretaceous series given in the 'Geology of the Neighbourhood of Cambridge' by Messrs. Penning and Jukes-Browne. The Middle Chalk was there described as separated from the Lower by the Melbourn Rock, which also appeared to coincide with a marked palæontological break, and from the Upper Chalk by the well-known Chalk Rock, this rocky bed, 10 feet in thickness, being included in the Middle Chalk. The division thus made corresponded exactly with the Turonian of French authors.

The author, giving a description of the Middle Chalk seen in the cliffs east and west of Dover, stated that the grit bed of Mr. Price, though much thicker, had all the appearance and structure of the Melbourn Rock, and this, with less hard, but still nodular, chalk above, appeared to be the equivalent of the zone of *H. Cuvieri* in Cambridgeshire. The zone of *Terebratulina gracilis* is well marked in the Dover cliffs, and is equal in thickness to that zone as described in the Cambr. Mem., viz. 150 feet. Above this zone the Chalk became harder, weathered, with lumpy projections, and finally passed into a series of rocky layers, separated by courses of softer chalk, containing, however, hard crystalline lumps. The passage to this rocky chalk was marked by the occurrence of *Holaster planus* (zone of *H. planus*). The rocky layers, extending upward for 80 feet, were marked by the presence of numbers of Micrasters, "Chalk with many Micrasters" of the author. His division included all the nodular chalk of Dover, the "chalk with many organic remains" of W. Phillips, and in it were found the fossils recorded as peculiar to Chalk Rock in the Geol. of Cambridgeshire. It appeared divisible into two zones; the lower, 15 feet, with *Micraster breviporus* (zone of *M. breviporus*), may be considered by some to be an extension of the zone of *H. planus*, the form which marks the passage from the soft to the hard chalk. In the remainder *M. cor-testudinarium* was common (zone of *M. cor-testudinarium*).

Seen in thin sections under the microscope, the structure of the

hard beds which mark the limits of the Middle Chalk was stated to be very similar.

In conclusion, the author considered that the divisions of the Middle Chalk, as set forth in the Cambr. Memoir, are well shown in the cliffs of Dover; but the hard beds which appeared to him the equivalent of the Chalk Rock, and mark the upper limit of Middle Chalk, attaining a great development at Dover, it became necessary to examine the palæontological position of that bed to which the name "Chalk Rock" was given by Mr. Whitaker. Having studied Mr. Whitaker's description given in the "Geology of the London Basin," and having examined exposures of this rock between Cambridge and the Thames, he came to the conclusion that there was probably more than one bed to which the name Chalk Rock might be applied, and that these, probably not all persistent, may occur at different palæontological horizons. He therefore proposed to take the zone of *H. planus* as the top of the Middle Chalk; although this zone was difficult to identify inland, from the paucity of its fossils, the base of the overlying zone was well marked by the abundance of Micrasters and other forms, which appear to him more closely allied to Upper than to Lower Chalk.

He believed that while the Chalk Rock seen at Henley may be considered the summit of the Middle Chalk, the Chalk Rock of Cambridgeshire, though convenient for marking the summit of the Middle Chalk of that county, included that which was really the upper part of the zone of *H. planus* and the base of the true Upper Chalk, the equivalent of Chalk with many Micrasters of Dover.

He would therefore consider the Middle Chalk of Dover to be that included from the base of the grit-bed to the summit of the zone of *H. planus*. Its thickness was 242 feet at Shakespeare's cliff. He was indebted to M. Curry, Esq., of Dover, for this accurate measurement.

IV.—Highbury Microscopical and Scientific Society.—At a numerously attended meeting of the members of this Society, held on Thursday, the 28th January, at Mr. E. P. Sell's, 63, Highbury Hill, the President, James Smith, Esq., F.L.S., F.R.A.S., moved, and Mr. Fitch seconded, the following resolution:—

> "That the Members of the Highbury Microscopical and Scientific Society having heard with the most sincere regret of the death of their Vice-President, Mr. J. B. Jeaffreson, M.R.C.S., desire to place upon record their deep sense of the loss they have sustained, and to express their appreciation and admiration, not only of his attainments as a scientific man, and the able manner in which he discharged the duties of President, but more especially of his character as a kind and sympathetic friend; and they furthermore desire that the Secretary do, in a suitable manner, convey to Mrs. Jeaffreson and the family the assurance of their heartfelt sympathy with them in their sorrow."

CORRESPONDENCE.

"CONE-IN-CONE."

SIR,—I am glad to observe in the short article on "Cone-in-cone," by Professor Newberry, M.D., in the December Number of the GEOLOGICAL MAGAZINE for 1885, that he at one time was inclined to look upon that structure as due to "the escape of gases through a pasty medium." I think that if he had the opportunity of studying the large series of specimens that I have now assembled, and the transparent sections of the cone structure that I have prepared, he would still be inclined to favour that view as an explanation of the phenomena that they present, rather than the one he now adopts, viz. "an imperfect crystallization" of the deposit in which it is found. Professor Newberry, after referring to a number of cases of cone-in-cone structure that had come under his observation (some of which apparently differ from what I have described), concludes by stating that these examples "seem to me to be incompatible with the theory that cone-in-cone is caused by pressure, or the escape of gases, and appear rather to confirm the conclusion that it is due to an impeded tendency to crystallization." He, however, in the article in question, offers no evidence in support of this crystallization theory, nor does he explain in any way the peculiar structure and arrangement of the cone layers. Those supporting a crystallization theory have not referred to any known law of crystallization, which would account for a structure agreeing with what is seen in the best-preserved specimens of our Scottish cone-in-cone, or which would satisfactorily explain all that is represented in the external structure of the cones, and their terminations on the surface of the bed, as is briefly noted in the short abstract of the paper I read to our Glasgow Geol. Soc., and printed in the June Number of the GEOL. MAG. for 1885. In the abstract, to which I would refer your readers, I have endeavoured to indicate what is seen in both the internal and external structure of the cones, but which I explain more fully in my paper, and I do not think that in either I have ventured to hazard any explanation that is not fully warranted by what the specimens reveal.

During the progress of my investigations, I have not wholly relied upon my own judgment in coming to the conclusion that the cone-in-cone structure was due to the escape of gases generated in the sediment, but that from time to time I have had the opportunity of submitting specimens and sections of the structure to Dr. Young, Prof. of Geology; Prof. Sir William Thomson, President of the Glasgow Geol. Soc., and his brother Prof. James Thomson, who has paid some attention to rock structures; likewise to Mr. Ferguson, Prof. of Chemistry in this University, and to others, on whose opinion I could rely, and I am pleased to be able to state, that they are all inclined—so far as the specimens noticed in my paper are concerned—to agree to the explanation I have given as to the probable origin of the structure. They also agree with me in thinking that none of the agencies to which cone-in-cone structure has been

usually ascribed—such as crystallization, pressure acting on concretions in the process of formation, or chemical deposition of sediment—will ever explain the points of structure and other characters seen *in the specimens that I have selected for description.*

Hunterian Museum,
University, Glasgow, *Jan. 5th*, 1886. John Young.

ON A NEW PERISSODACTYLE UNGULATE FROM WYOMING.

Sir,—In the Geological Magazine for February, 1886, it is stated, p. 50, that no Perissodactyle mammal was known "to possess tubercular teeth." Professor Cope does not supply the characters to which his term 'tubercular' is applicable. If he would kindly refer to p. 362 of my "Palæontology" (2nd ed. 1861), enlarged views of the molars of both jaws of a genus of Perissodactyles (*Pliolophus*), from Eocene, will be found. A still earlier example of 'tubercular' molars, in the genus *Hyracotherium*, is described and figured in "British Fossil Mammals and Birds," 8vo., 1846, p. 422, cut 166: also from the 'London Clay.'

Permit me to add that my estimate of the claims of Elephants and Mastodonts to rank as an 'Order' rests upon the multilamellate structure, size and succession of their 'grinders,' subordinate to which dental character may be cited a vertebral one, necessitating their special instrument the proboscis. The pentadactyle character is common to *Proboscidia* with many Rodent genera, as well as with the older Eocene members of the Coryphodont family, characterized by Lophiodontoid modifications of the true molars. These teeth afford the truest indications of affinity in the Ungulate series. The diminutive Rhinocerontoid represented by the genus *Hyrax* as little determines by molar characters an ordinal distinction form *Acerotherium* as do the modifications of teeth and limbs in *Bradypus* support an ordinal distinction in the Megatherioid family.

Richard Owen.

THE "ALASKA GLACIER."

Sir,—In reference to the description of the *Great Glacier* in Alaska, in "Nature" (Jan. 28th, 1886), I may draw attention to the letter of Mr. J. Melvin in the same number, which would appear to throw light on the subject of the progressive changes in it. The *ridges* delineated in the diagram of the Glacier as lying between the body of the Ice and the hill-side would seem to be analogous to the *Parallel Roads* in Norway valleys, only they are formed on the flat instead of the slope.

The body of the Glacier seems evidently to have *contracted itself* in consequence of loss of substance by melting underneath, and withdrawn itself by *these decided starts* from the hill-side, and left the ridges as relics of its foundations on the bottom of the valley.

Probably the Glacier ages ago was *quite flat* on the top, and reached across to the top of the morainic slope on the hill-side, and it has since lost great bulk below by *ground melting*, which by overstretching has caused the cracks or *crevasses* on the upper

surface by consequence of change of shape from the level to the convex.

The *tunnel*, opening out at the butt of the Glacier on to the sea-beach, has doubtless been the main *outlet* for the *ground melting*, and its arched shape may also be deemed significant of the process of convexity adopted by the contraction of the Glacier from side to side.

The mechanism may be likened to the *curling in of the sides* of a piece of wood or paper when the flat side is exposed to the fire,—and it would be all the greater if the other surface were *damped*, just as the upper surface of the Glacier would be by the rainfall or snowfall of the season. Mr. Melvin's explanation of the formation of the *Parallel Roads* in Norway valleys may therefore be provisionally proposed to be applied to the phenomena of *other Glacier actions*, but there are many of these probably that have not convex roofs, nor ground tunnels like the Alaska Glacier. W. J. Black.

United Service Club, Edinburgh, *February*, 1886.

EDESTUS AND *PELECOPTERUS*, ETC.

Sir,—I observe in your interesting article on the *Edestus Davisii*, in the January Number of the Geological Magazine, that you refer to the genus *Pelecopterus*, Cope, as identical with *Ptychodus*, Agass.; the pectoral spines representing the former being supposed to belong to the animal whose teeth have given origin to the second name.

My studies of these fishes have led me to entertain a different opinion from the above. *Ptychodus*, being a shark, is not likely to have a pectoral arch and fin like that of *Pelecopterus*. Moreover, these pectoral spines have been frequently found associated with the jaws and teeth of the "snout-fishes" of the Kansas Chalk, which have been described under the generic head of *Erisichthe*, Cope. Several species are known (see Bulletin U.S. Geol. Survey Terrs. iii. 1877), and one of them is probably the *Xiphias Dixoni* of Agassiz, from the Chalk of Sussex, England. These genera cannot be referred to any of the existing orders of fishes, on account of the peculiar structure of the pectoral arch. I have therefore placed them in an especial one, the *Actinopteri* (see Proceedings Amer. Assoc. Adv. Science, 1877(78), p. 299). E. D. Cope.

Philadelphia, *Jan.* 26, 1886.

NOTE ON THE ABOVE, BY MR. W. DAVIES, F.G.S.

Professor Cope is, I think, mistaken in assigning *Xiphias Dixoni* to Agassiz. The name first appears in a paper by Dr. Leidy "On *Saurocephalus* and its Allies," in the Trans. Am. Phil. Soc. vol. xi. p. 91, where the name was given to the prolonged ethmoid bone referred by Sir Philip Egerton to *Saurocephalus lanciformis*, as then understood.

In that paper Dr. Leidy proves that the teeth assigned by Agassiz to the *Saurocephalus* of Harlan had no relation to that genus, and he refers the jaws and teeth from the English Chalk to a new genus; under the name of *Protosphyræna*, Leidy. The "rostral" bones described by Sir Philip Egerton, he contended did not belong to

Protosphyræna, but to a species of *Xiphias* to which he gave the trivial name of *X. Dixoni*. Subsequently, Prof. Cope described his genus *Erisichthe*, which certainly embodies both of Leidy's species. I may mention here that the prolonged ethmoids are found in our Chalk, Upper Greensand, and Gault; and here also are found (and in no other deposit) the peculiar fin-rays referred to *Ptychodus* by Agassiz. From this association the inference is natural, that the ethmoids and fins belong to the same species of fish, viz. the *Protosphyræna* of Leidy, *Erisichthe*, Cope. (See paper by W. Davies, F.G.S., on *Saurocephalus lanciformis* of the British Cretaceous Deposits, with description of a new species, Geol. Mag. 1878, Decade II. Vol. V. p. 254, Pl. VIII.)—W. D.

A MONUMENT TO HORACE-BÉNÉDICT DE SAUSSURE.[1]

(Born at Geneva, 1740; Died 1799.)

Sir,—Chamounix is preparing to erect a monument in memory of our fellow-citizen H. B. de Saussure.

This memorial will be placed at the foot of Mont Blanc, whose lofty summit the illustrious savant indefatigably reached, not far distant from the Col du Géant, where, in pursuit of science, he encamped amidst snow and ice for sixteen days. In short, it will adorn the central position from which all the Alpine excursions of this intrepid explorer originated.

It is impossible to enumerate here all the titles acquired by De Saussure in the scientific world. Let us only remember that he was an eminent physician, a distinguished meteorologist, a charming writer, who devoted thirty of the best years of his life to the study of those Alps whose beauties he revealed with precision and poetic feeling, and as a conscientious and indefatigable investigator he became one of the founders of modern geology by placing that science on its true basis—*observation*.

The proposal to raise a monument naturally met with the most sympathetic support when it was presented to the members of the Alpine Clubs of all countries, who met at Chamounix in August, 1883, and at Turin in August, 1885.

Since then an Executive Committee has been formed, composed of Messrs. Folliguet (Mayor of Chamounix), Tairrez Payot, Thévenet, President, and Maillot, Secretary of the Mount Blanc section of the French Alpine Club, soliciting them to assist with their subscriptions the erection of a monument.

Switzerland and Geneva in particular would wish to be associated with the homage rendered to the merits of our eminent citizen. Above all, the people of Geneva ought to be interested in a monument designed to preserve the memory of a man who shed such lustre on our city and our ancient Academy. One knows, in fact, that in spite of his numerous travels and his absorbing scientific studies, he found time during many years to occupy a modest

[1] Among various writings, his most important work is the record of his Alpine observations: "Voyages dans les Alpes," in 4 vols. 1779–96.

philosophical chair in his native town, where he exhibited all the high qualities of his exalted intellect.

It is equally well known that he interested himself all his life in our scientific and literary institutions as well as the intellectual and material development of our ancient Republic. Many of his writings, unknown doubtless elsewhere, were received here, and the Society for the Advancement of Art founded by him still continues a work to which he was devoted.

Even when this monument to his memory shall have been raised on foreign soil, Geneva will show its gratitude towards those who have taken the initiative in this demonstration, and will honour those who take part in it.

It is with this firm assurance that the Committee at Geneva is formed to collect subscriptions.

The inauguration of the memorial is projected for the 3rd of August, 1887, that being the centenary of H. B. de Saussure's ascent of Mont Blanc. There is therefore no time to be lost that it may be finished by that date. It is important that the Initiative Committee at Chamounix should know as soon as possible the sum they have at their disposal, in order to decide what form the monument should take.

ALPHONSE FAVRE,
President of the Swiss
Geological Commission.

6, RUE DES GRANGES, GENEVA,
20th December, 1885.

A MONUMENT FOR PROFESSOR OSWALD HEER OF ZURICH.

SIR,—Two years have passed since Death carried off one of the most eminent naturalists of our age—Oswald Heer. He died on the 27th of September, 1883. The fitting moment seems to have arisen to render Dr. Heer a public acknowledgment and to raise a lasting monument to his memory. We are glad to be able to inform you that a sculptor of Zurich, M. Hörbst, has modelled a bust in clay, which gives the naturalist's expression in the most pleasing manner.

The work of Heer was wide-spread. Although truly Swiss at heart, and studying with delight the primitive history and flora of his native land, his researches extended far beyond the limits of his own country. He had become one of the highest authorities on the domain of vegetable palæontology, and from all parts of the world, from the islands of Sunda and from "hyperborean" lands, from Portugal and Eastern Siberia, from the New World as well as the Old, he gathered materials for his researches, and specimens came for identification. The works of Heer on the fossil flora of the Polar regions have placed him among the foremost ranks as one of the founders of modern botanical geography; for to him, and him alone, is due the merit of having discovered, by studying the marvellous Tertiary flora of Greenland, Spitzbergen, and Arctic America, facts of the utmost importance to science. His name will perpetually remain united with those who have explored Arctic regions, his researches will long form the basis of our knowledge of prehistoric climates.

Feeling assured of the eminently international character of Heer's

work, we confidently appeal to all to raise a worthy monument to his memory.

It is proposed that this monument should consist of a marble bust on a stone pedestal, protected in a suitable manner from the inclemencies of the weather, to be placed in the Botanical Gardens at Zurich, on the spot where Heer's energy was so well displayed. The price of the memorial would reach about 5000 francs.

Besides which, the sculptor, M. Hörbst, is prepared to execute, for 150 francs each, plaster casts of the original. If you desire one of these copies, have the goodness to inform us, when sending your contribution. Subscriptions will be gratefully received by Dr. C. Schröter at Hottingen, Zurich. They may be sent direct, or through the medium of the undersigned.

Prof. Dr. A. Mousson, Polytechnikum, Zurich.
Prof. Dr. C. Cramer, „ „

OBITUARY.

PROFESSOR A. VON LASAULX PH.D.

We deeply regret to have received tidings of the death of this distinguished German Geologist and Mineralogist, which took place at Bonn, on the 25th January last, after a short illness. Dr. Von Lasaulx was only in his 47th year; yet he had been the author of a remarkably large number of Memoirs on petrological subjects, as well as of more solid works, of which, perhaps, the joint work on Etna of Sartorius von Waltershausen and himself is the most splendid example. In 1876 Dr. von Lasaulx, in company with his friend Dr. Ferdinand Roemer, of Breslau, visited the British Isles; and was present at the meeting of the British Association in Glasgow in that year. On his return to Bonn, he published an account of his wanderings, in the form of a handsome book, "Aus Irland, Reiseskizzen und Studien," in which the physical features and geological structure of the districts visited are closely noted and graphically described, together with the mineral characters and composition of many of the rocks as determined under the microscope; of these, the most important was the discovery of tridymite in the trachytic rocks of Antrim (Petrographische skizze aus Irland; mineralogischen und petrographischen Mittheilungen, Wien, 1878, p. 410). The volcanic rocks of Bonn and the neighbourhood afforded a rich field for the petrological investigations of this lamented naturalist, of which he made abundant use. E. H.

We regret to record the death (on the 16th February, from heart-disease) of Mr. W. W. Leighton, who, since the year 1867, has filled the office of Clerk to the Geological Society of London, and has during 19 years been a most faithful and valued servant to the Society.